ENERGY 2000

THE SHAPE OF ONTARIO'S ENERGY DEMAND

Ontario

Ministry of Energy

Honourable Vincent G. Kerrio Minister

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The Shape of Ontario's Energy Demand

Foreword

The year 2000 is only 15 years away.

By the year 2000 it will have been almost 30 years since the Organization of Petroleum Exporting Countries shocked Canada and the rest of the world by quadrupling the price of their oil. New energy-using technologies, many of them developed in response to the energy price rises of the 1973-83 decade, will have transformed our homes, cars and workplaces.

How much energy will the people of Ontario need at the turn of the century? Where will Ontario's supplies of this energy come from?

These questions are addressed in two papers produced by the Ministry of Energy. This paper, **The Shape of Ontario's Energy Demand**, looks at the first question. A companion paper, **Fuelling Ontario's Future**, looks at the second question.

The papers have been written to provide information and to stimulate discussion. Descriptions of alternative futures are presented — ranges of possible international energy prices, varying patterns of price changes, and different levels of economic growth are described and their implications for energy demand are assessed. Against this background, supply options for Canada and Ontario are discussed. The papers highlight options and issues. As such, they do not end with a series of policy recommendations. These will result from wide discussions and from further examination of the issues and options for energy supply and demand to the year 2000.

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EXECUTIVE SUMMARY

Ontario's need for energy is expected to grow only moderately in the next fifteen years, as households and businesses invest in new energy-efficient equipment. This is the principal conclusion of an in-depth study of the province's potential energy demand in the year 2000 conducted by the Ontario Ministry of Energy.

The study examines a base or most-likely outlook for energy demand, and two alternative scenarios covering a range of possibilities for the economy, energy prices, technological change and population growth.

Key Findings

- Even with a healthy economic expansion and rising standards of living, energy needs will grow by only one-third as much as the projected growth of the economy.
- The province's overall energy efficiency will improve by 20 per cent or more, because of fundamental changes in the way energy will be used in homes, commercial structures, factories and vehicles. Widespread technological changes will affect the production of goods and services and lower the requirements for energy in relation to economic activity.
- The greatest improvements are likely to be in home heating and automobile fuel efficiency: the average home could require 25 per cent less energy by 2000, and the average car could be around 30 per cent more fuel-efficient.
- Increased use of electricity will be at the forefront of industrial expansion, and total electricity needs in the base outlook could grow to be 40 per cent greater by the year 2000.
- Total oil use could fall by some 5 per cent in the base outlook, and Ontario's dependence on oil could be reduced to less than one-third of total energy use.
- Natural gas will hold its share of the total energy market, but significant growth in its use would require price reductions to attract new customers.
- Renewable energy sources, other than hydroelectric power, will face tough competition from conventional fuels, but could provide some 4 per cent of energy use by 2000.

The prices of the major energy sources are expected in the base outlook to be relatively stable in the coming years. Crude oil prices could remain soft for the balance of the 1980s, and then recover in the 1990s as world demand and supply come into balance. Natural gas prices could follow a similar path, while electricity prices in Ontario are likely to rise no faster than the rate of inflation. Alternative scenarios could see oil and gas prices

some 25 per cent above or below the base outlook by 2000 — which would respectively lower or raise the energy demand forecast — but a long-term collapse of world oil prices is not considered likely.

One of the key determinants of the energy outlook is the pace of expansion of the provincial economy, which in turn will depend on success in world markets for Ontario's industrial output. The base outlook foresees moderate economic growth, averaging 2.7 per cent a year until 2000. Despite international competition, major industries such as steel and pulp and paper will remain strong, and will require more energy. On the other hand, the continuing trend toward service-oriented activities and a knowledge-based economy will tend to restrain energy demand growth.

The massive energy price increases of the 1973-83 decade will continue to suppress demand well into the future, as the old stock of vehicles, buildings, machines and equipment is replaced by new energy-efficient stock. Improved technology will be introduced in every area of energy use. Electricity — the most versatile and controllable energy form — will play a key role in new technologies which enhance productivity and serve people's life-style preferences.

Increased investment will be required in order to upgrade the province's capital stock. In meeting this challenge both energy efficiency and economic productivity will be increased, thus strengthening Ontario's competitiveness and raising living standards.

INTRODUCTION

Planning for the Future

Energy is vital to a modern industrial economy. Energy is needed to heat and light our homes, power our machines and cars, and fuel our industries. Its importance can be gauged from the fact that Ontario spent over $14 billion on energy in 1984, equivalent to almost one-tenth of the value of all goods and services produced in the province.

Despite dramatic reductions in oil consumption and slower growth in total energy use in the last few years, Ontario and Canada are still heavy users of energy. Canadians use one-sixth more energy per capita than Americans and almost twice as much as Swedes. This high level of use has arisen from a combination of factors, including a relative abundance of low cost energy, a cold climate, long transportation distances, a resource-based industrial economy and a high standard of living.

Reducing the province's energy use without sacrificing jobs or living standards is a fundamental goal of the Ontario government. There are many reasons for this.

- Over one-third of our manufacturing industry depends on export markets for sales. Many of these industries are heavy users of energy. Increased energy efficiency will enhance industry's ability to compete in export markets.
- Seventy per cent of the energy used in Ontario — essentially all the oil, natural gas and coal — comes from outside the province. Using less energy will leave more spending power within the province.
- Lower energy use will help postpone the requirement for more expensive oil and natural gas supplies from the frontiers.
- The vast majority of the world's conventional oil reserves lies in the Middle East. Although supplies are plentiful today, in the long run the security of supply from this region cannot be guaranteed.

In response to these realities, the Ontario government has instituted programs and set targets in key areas of the economy. The aim is to improve energy efficiency i.e. to reduce energy use per unit of economic activity, and to substitute other fuels for oil.

INTRODUCTION

How will Ontario's energy needs change between now and the year 2000? Answering this question involves examining all the different areas in which energy is used:

- in **homes**, where new super energy-efficient designs and vastly improved heating systems promise dramatic reductions in energy bills;
- in **commercial buildings**, where heat storage and control systems allow new office buildings to be run on one-fifth the energy of buildings constructed before the 1970s;
- in **transportation**, where the advent of fuel-efficient cars in place of the gas-guzzlers of yesterday could continue to cut Ontario's use of gasoline; and
- in **industry**, where intense international competition and technological changes pose major challenges for the province's steel, pulp and paper, petrochemical and other energy-hungry industries.

Understanding how much and what type of energy will be needed fifteen to twenty years ahead is important, because major policy and planning decisions must be made years in advance.

For example:

- Will Canada remain self-sufficient in crude oil, or will imports be required to fill the gap? If the latter, should further measures be taken to lower oil demand and encourage new supplies?
- How much natural gas will be needed for a future generation of Canadians, and how much should be allowed for export?
- How much more electricity will Ontario need in the future, and when will new facilities for electricity generation be required to meet that need?

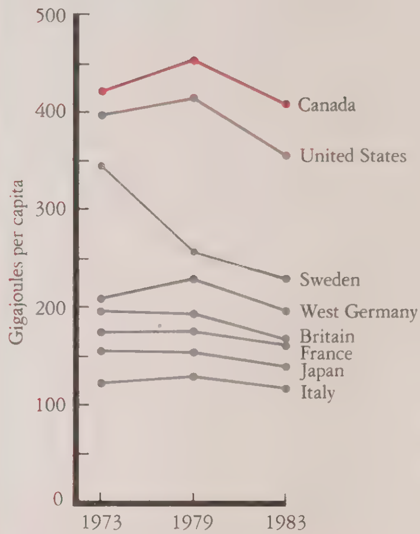
To answer these questions requires examining the prospects for energy supply as well as demand. Supply options are discussed in a companion publication entitled **Fuelling Ontario's Future.**

Canada's High Energy Consumption

One reason for Canada's high per capita energy consumption is that a large part of our economic output is produced by industries that use a lot of energy.

Canada has only 4 per cent of the total output of the industrialized nations of the Organization for Economic Co-operation and Development (OECD), but accounts for 40 per cent of newsprint production, 33 per cent of aluminum production, 30 per cent of nickel production, 17 per cent of iron ore production, and close to 10 per cent of OECD production of copper, zinc, lead and synthetic ammonia.

Energy Consumption per Capita



'End-use' Energy

The 'consumption' of energy means the controlled conversion of energy into heat, light and motive power by end-users.

'End-use energy' is that which is consumed at the point of use: such as in furnaces, car engines, electric motors, lights, and industrial boilers. It also includes so-called 'non-energy use' — mainly crude oil used for petrochemical feedstocks and products such as lubricating oils, waxes and asphalt. The four major forms of end-use energy are petroleum products (such as gasoline), natural gas, electricity and coal.

A somewhat different concept of energy use is 'primary energy'. This is the sum

of end-use energy and two other quantities: (1) the extra energy used in electricity generation, and (2) the energy used by the energy supply industries themselves, either to transform the raw energy form into usable products (such as in refining crude oil to produce petroleum products) or to deliver energy to customers (such as in pipelining natural gas or the transmission of electricity).

The focus of this report is on end-use energy. Appendix A shows both end-use and primary energy consumption and how they are related.

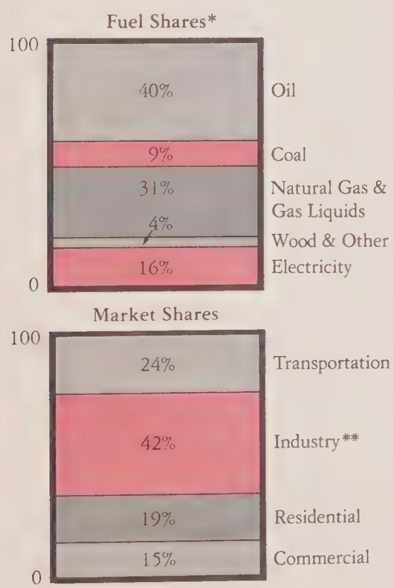
Units of Energy Use

The units of energy consumption used in this report are:

- the gigajoule (GJ), which is roughly the energy contained in a half tankful of gasoline, and
- the petajoule (PJ), or one million gigajoules, which is roughly the energy used by all the cars in Ontario in one day.

A typical Ontarian might use 220 GJ of energy for personal and household use in one year: 70 GJ in the car (2000 litres of gasoline), 100 GJ for home heating, and 50 GJ for water heating, appliances and electrical equipment.

Energy Fuels and Markets in Ontario (1984)



* Based on end-uses
** Includes petrochemical and non-energy uses

Outlook Scenarios

Uncertainty is a fact of life whenever the future is considered, and this paper gives not just the Ministry's base or most likely view of future energy needs but also a low-demand and a high-demand view.

- The **base outlook** is founded on moderate growth of the Ontario economy (averaging 2.7% a year), and energy prices which overall are only slightly higher in 2000 than at present.
- The **low-demand outlook** reflects a combination of factors which tend to depress the demand for energy. Slow economic growth and high energy prices are the main factors incorporated in this scenario.
- The **high-demand outlook** reflects circumstances of high economic growth, high population growth and relatively low energy prices that will push up the demand for energy.

The three outlooks are based on a detailed analysis of end-use demand for energy in each area of the economy. Together, they serve to examine a range of possibilities that need to be considered in planning for the future.

Many factors will affect Ontario's energy needs in 2000, ranging from the competitiveness of the steel industry to the popularity of car pools. This paper reviews in Section 2 the broad forces of change which will affect energy needs throughout the economy. With this background, Section 3 examines in detail the end-use areas where energy is consumed for residential, commercial, transportation and industrial purposes. Section 4 assesses the total picture obtained by aggregating these diverse energy uses into the demands for oil, natural gas, electricity, coal and other energy sources.

FORCES OF CHANGE

The Impetus for Conservation and Substitution

Energy consumption in Ontario has changed a great deal in the last fifteen years. First, there has been a sharp drop in the amount of energy used relative to the amount of economic activity. Second, there has been a major shift in the fuels used, away from oil and to electricity, natural gas, coal and wood.

- Between 1979 and 1984, the amount of energy used per unit of economic output was cut by 10 per cent in Ontario. The economy has grown while energy use has declined.
- Oil use has fallen 21 per cent since 1979 and is now below the level of the early 1970s.
- Natural gas consumption has remained almost unchanged since 1974, despite capturing huge heating markets from oil.
- Electricity consumption has increased by 33 per cent in the last decade, but the growth rate — only 2.7 per cent a year since 1976 — is less than half the rate experienced in the previous fifteen years.

What are the prospects for the next fifteen years? Will the savings in energy use of the last decade — and particularly oil use — be reversed? These questions are important because conservation and substitution will have to proceed under very different circumstances from the recent past.

- Energy price changes in the next 15 years are not likely to be dramatic —no large price increases, but also no major reductions.
- Technological change, much of it stimulated by earlier energy price hikes, will work its way slowly but surely through the economy as the capital stock is replaced by more energy-efficient equipment.
- Government programs that spurred conservation and oil substitution are being curtailed or eliminated.

Part of the answer lies in behaviour. For years now, people have been turning down their thermostats, businesses have been reducing unnecessary lighting, and industries have been eliminating energy waste. These behavioural changes will continue to be important.

However, the greater part of the answer lies in investments. They provide the means for harvesting the gains from technological and structural change. People will be buying new homes, cars, and electrical appliances which are more energy efficient. Businesses will be occupying new offices, investing in new technologies and processes, and upgrading their machinery. These and other investments in energy-efficient equipment will lead to the greatest and most permanent reductions in energy use.

The balance of this section sets the stage. It examines the major forces that will shape Ontario's energy future — prices, technological change, population growth and the changing economy. The specific impacts of these forces on energy demand in particular uses are described in Section 3: Energy Use in the Year 2000.

Key Factors Shaping Energy Demand

Energy Prices

World oil prices quadrupled in 1973-74 following the Arab oil embargo and more than doubled in 1979-81, following the Iranian revolution. While the first price shock slowed the growth of world oil consumption, it did not fundamentally reverse it, and oil use soon began to rise again. The second price shock cut oil consumption by 15 per cent, and this, together with increased oil supply, caused a glut of oil on world markets that seems likely to persist for several years.

In Ontario, the prices of oil and other energy forms have changed equally dramatically. In the period 1973 to 1984, prices rose in real terms (that is, after subtracting inflation), almost 300 per cent for crude oil, more than 200 per cent for natural gas, and more than 100 per cent for coal. Electricity prices also rose, but only by one third.

How Prices Affect Consumption

Consumers and businesses responded to these price increases by cutting their total energy consumption, and by switching from oil to other fuels. Most of the impact, however, was delayed until after the second wave of price increases.

Between 1979 and 1984, Ontario's energy use per person fell by 7 per cent. Oil, whose price had risen the most, showed the largest change. Oil use per person fell by one-third.

Price increases were not the only cause of the drop in consumption. Government programs played a major part, such as the federal programs for home insulation (CHIP) and heating oil substitution (COSP), or Ontario incentives for alternative transportation fuels. The 1981-82 recession also dramatically cut energy use, particularly by industry.

Analysis of the price effects and recession effects is illuminating. It is estimated that when Ontario's energy demand dropped by 12 per cent in the 1982 recession, only about two-fifths of the decline was the direct result of price increases. The other three-fifths was caused by the recession, which

What are 'Real' Price Increases?

The price of an item goes up in real terms when it rises faster than the prices of other goods, that is, faster than the general rate of inflation.

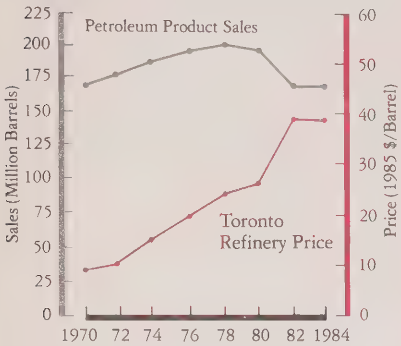
The price of a litre of gasoline rose from 12 cents in 1973 to 46 cents in 1984, which is a 'nominal' increase of 283 per cent. In real terms, however, after allowing for the general rate of inflation in those years, the gasoline price rose by 50 per cent. (Incidentally, real gasoline prices went up less than crude oil prices, because the costs of refining, distributing, and retailing the oil, and the tax on gasoline, rose by less than inflation).

Price changes in this report are all expressed in real terms to remove the effects of general inflation. Sometimes prices in real terms will be described "in 1985 dollars", which means that any general price inflation prior to or after 1985 has been removed.

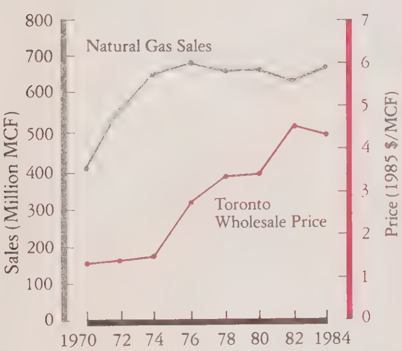
Real Energy Price Changes (1973-84)

	$ per GJ in 1985 Dollars 1973	1984	% Change
Crude Oil	1.64	6.30	+282
Natural Gas	1.24	4.02	+224
Coal	1.21	2.56	+111
Electricity	7.66	10.12	+ 32

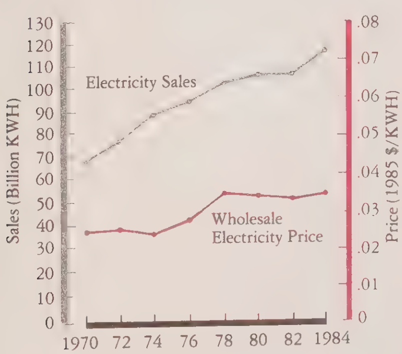
Oil Prices and Consumption in Ontario



Natural Gas Prices and Consumption in Ontario



Electricity Prices and Consumption in Ontario



drastically affected Ontario's industry and transportation sectors. Furthermore, most of the price-induced drop in consumption was in fact a delayed effect of the price increases prior to 1979, which was just appearing in the form of fuel-efficient cars, highly-insulated houses, and energy-saving equipment.

The full impact of the 1980 to 1982 oil and natural gas price changes has not been felt yet.

It takes time to replace old inefficient equipment, sometimes more than twenty years in particular areas of the economy. For example, many buildings constructed before 1973 will still be standing well into the next century. For cars and trucks, it takes from six to twelve years before they are replaced. Although the pace of technological change is increasing, some industrial processes with major capital investments, such as steel making, may not have been fundamentally changed for thirty years.

Therefore, the sharp increase in oil and natural gas prices that has occurred since 1980 will affect our economy for many years, as the stock of energy-using equipment is scrapped and replaced.

The Outlook for Oil Prices

With the removal of government controls in June 1985, crude oil prices in Canada will be largely determined by prices on international crude oil markets. Although world prices are currently under downward pressure, oil demand could recover enough to push up prices by the end of the century. In the base case scenario, prices are projected to be higher in real terms in 2000 than they are today. Plausible alternative scenarios can be foreseen, however, in which world prices by the year 2000 could be as much as 25 per cent higher or lower than in the base outlook.

The world oil market is quite unstable at present, and is likely to remain so for some years. Prices have already fallen by $6 or $7 from their peak of $34 U.S. per barrel in 1981. As long as excess capacity remains significant, OPEC, like any other cartel, will have difficulty in maintaining control over price and production within the group.

The fundamental causes of today's surplus oil production capacity — and hence of price instability — are the fall in world oil consumption in the last five years and the increase in oil production by non-OPEC nations, particularly the U.K., Norway and Mexico.

The base price outlook adopted for this report is that world oil prices will fall somewhat in real terms in the next two years, but that a severe price collapse will not occur. During the balance of the decade world oil demand should gradually increase under the stimulus of a healthy expansion of the world economy, particularly in the developing nations. Supply from non-OPEC nations is not expected to rise in the 1990s. More likely, production would decline in countries such as the U.K. and U.S.A. The demand for OPEC oil would grow and this would enhance OPEC's ability to resist the pressure for major price cuts.

By the early 1990s, demand growth could be sufficient to push up oil prices, by perhaps 20 per cent in our base outlook. Subsequently prices would decline somewhat as demand reacts to the price change, and then rise in the late 1990s, reaching a level in 2000 of around $34 U.S. (in 1985 dollars). This would still be lower in real terms than the oil price peak reached in 1981.

Alternative Oil Price Scenarios

The low price scenario projects a continuing decline in prices during the next five years, and then a cyclical path of small increases and corrections, keeping prices in the range of $22 to $26 U.S. per barrel (in 1985 dollars) during the 1990s. The price weakness in the 1980s is highly plausible given the current surplus supply and the uncertainty about how much demand will recover. The absence of significant price rises in the 1990s could arise in the event of slow world economic growth, further increases in non-OPEC oil supply, or greater-than-expected oil conservation.

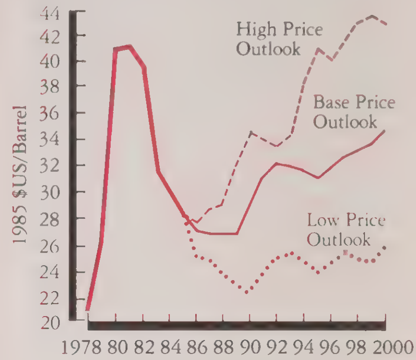
The high price scenario projects a situation where world oil demand recovers faster than in the base scenario under the influence of sustained economic growth. Prices could remain close to 1985 levels in real terms for three to five years before ratcheting upward around the turn of the decade. The situation could resemble a supply shock, albeit mild in comparison with the experience of the 1970s. In such an event, prices could be pushed up to a level of some $43 U.S. per barrel (in 1985 dollars) by the end of the century.

Although the high oil price scenario appears unlikely at present, it is a possibility which should not be overruled in looking at the next fifteen years.

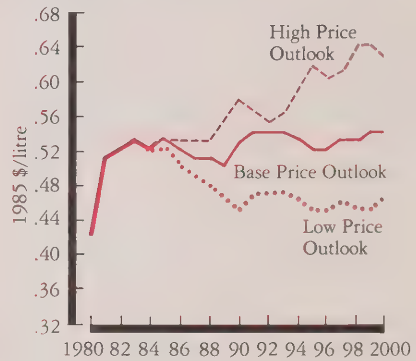
Gasoline and Heating Oil Prices

Currently, the price of gasoline in Ontario is being kept down by oversupply and intense competition among refiners. These same market conditions could persist for several years and keep prices weak. However, some strengthening in the 1990s is likely as the competitive situation among

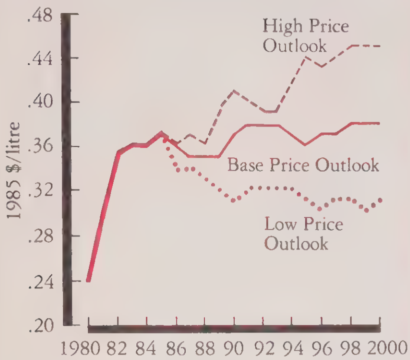
World Oil Price (Official Price of Arabian Light in 1985 U.S. Dollars)



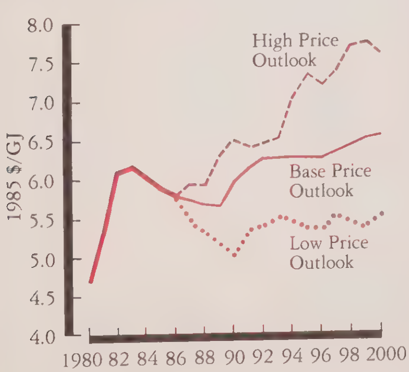
Ontario Gasoline Prices (Regular Unleaded)



Ontario Heating Oil Prices



Ontario Natural Gas Prices (Residential)



refiners eases, and as crude oil prices recover. On balance, the base outlook is that a litre of regular unleaded gasoline could cost around 51 cents (in 1985 dollars) for much of the 1980s, rising to about 54 cents by 2000. The alternative scenarios of low and high world oil prices could see this price as low as 46 cents or as high as 63 cents a litre in 2000.

The price of home heating oil would follow a similar path, and in the base outlook could be around 38 cents a litre in 1985 dollars by 2000.

Natural Gas Prices

The Canadian price of natural gas has been set by government regulation for many years. Under this administered system the price has risen significantly, reflecting government revenue targets and industry rent collection from final consumers rather than the dynamics of demand and supply.

Many people are now advocating a more competitive pricing system, which can respond more quickly to market forces such as the present surplus of natural gas and pressures from competing fuel markets. In the United States, partial deregulation of the natural gas system is already resulting in lower prices and highly competitive bidding for markets by gas suppliers. In the future it is likely that Canadian pricing will also become less regulated and more competitive.

The price of natural gas will be influenced by oil prices because these fuels can be substituted for each other in many uses. For example, many industrial firms can switch their boilers from heavy fuel oil to natural gas at short notice. Natural gas will also have to compete with coal, electricity and in some cases wood, to keep its existing customers and to attract new ones.

In light of the relative abundance of natural gas, the wholesale price in Ontario is not expected to rise in relation to oil prices until perhaps the mid-1990s. By that time, the North American surplus may be sufficiently reduced to push up natural gas prices at a faster pace than other fuel prices. Retail prices could become more flexible as a result of competitive forces, particularly in industrial markets.

Considering all these factors, the real price of natural gas to residential customers is expected to remain at or below present levels for the rest of the 1980s. During the 1990s, natural gas prices could strengthen somewhat, with the result that the price in 2000 could be some 10 per cent higher in real terms than today.

Prices to industrial users are expected to follow a similar path, although perhaps with more flexibility in the price, reflecting market circumstances under deregulation.

The outlook for natural gas prices could be significantly affected if oil prices were to remain weak, thus increasing the competition from heavy fuel oil. A low price scenario for natural gas could see real prices some 15 to 20 per cent lower by 2000 than in the base outlook, lower in fact than today's prices.

On the other hand, higher oil prices and greater export demand for natural gas could pull natural gas prices to higher levels in the 1990s. A high price scenario could see real prices some 15 to 20 per cent higher than in the base outlook by 2000. (This would be 25 to 35 per cent higher than today's prices.)

In all scenarios, natural gas is expected to retain its competitive advantage over oil in heating markets, as the chart shows for residential fuels.

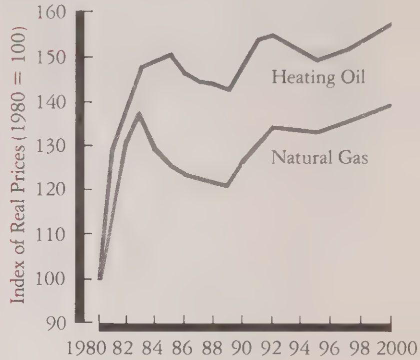
Electricity Prices

Future electricity prices in Ontario are much less uncertain than prices of oil or natural gas. Electrical power rates are largely cost-determined, and the capital costs of the major generating stations that will provide Ontario's electricity in the 1990s are fairly well known. Between 1985 and 1992, new nuclear units at the Bruce, Pickering and Darlington stations are scheduled to come into service, when their capital costs will begin to be reflected in electricity rates. (For the later 1990s, alternative ways of meeting Ontario's electricity needs are reviewed in the publication **Fuelling Ontario's Future.**)

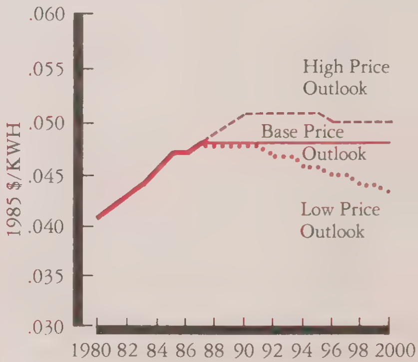
The effect of the new nuclear stations on rates will depend partly on Ontario Hydro's ability to control fuel, operating and other costs, and partly on the growth in demand for electricity. Higher demand growth will allow the added capital costs to be spread over more units of electricity, resulting in lower rate increases because the fuel and operating costs of nuclear stations are relatively small. In the longer term, these low operating costs could allow electricity rates to fall in real terms.

Electricity rates would also tend to be lower in real terms if interest rates fall or the Canadian dollar appreciates more than expected. Lower interest rates reduce the cost of money borrowed to construct new stations, while a higher Canadian dollar reduces the costs of imported coal and of repaying money borrowed abroad. Conversely, lower growth in electricity demand, higher interest rates, and a lower dollar will tend to increase electricity rates.

Comparison Index of Natural Gas and Heating Oil Prices (Residential)



Ontario Electricity Prices (Residential)



In this light, the base outlook for electricity prices is for no increase in rates in real terms for the balance of the century.

This will improve the competitive position of electricity with respect to other fuels in the 1990s. Different scenarios for economic growth, interest rates and operating performance could lead to a range of electricity prices varying by about 7 or 9 per cent above or below the base outlook by the year 2000.

Technological Change

The history of mankind's energy use can be regarded as one of progressive evolution of technology. From the first use of smelting that introduced the Bronze Age, to the steam engine and water wheels that powered the Industrial Revolution, to the vast array of machines driven today by electricity, technological change has constantly expanded the range of goods and services at our disposal. Most of these changes have resulted in increased energy use.

The changes in technology over the next fifteen years could be as profound as in any comparable period in the past; in fact, the pace of technological change is increasing. The implications for energy use, however, will be very different. Energy is no longer cheap, and the focus of much technology will be on improving energy efficiency, in other words, using less energy to produce the same or greater output.

Broadly speaking, technological change will improve energy efficiency in three ways:

- Existing technologies for energy conversion will be dramatically improved. The condensing natural gas furnace, for example, by condensing the exhaust gases to recover heat otherwise wasted, can produce the same usable heat as a conventional furnace with one-third less fuel.
- New technical processes will be introduced for a host of reasons — better quality, lower costs, reduced environmental impact, for example — and will bring improved energy-efficiency as a side benefit. Often these processes will involve switching to another fuel. The possible introduction of plasma arc furnaces in metal forming and smelting is an example.
- New materials will be introduced that reduce the need for energy-intensive materials. For example, lightweight packaging will reduce the demand for glass. As another example, in new cars, lightweight plastic and composite materials have already replaced up to 40 per cent of the steel component. This reduces the demand for steel and thus the steel industry's demand for energy below what it might otherwise be. (The total demand for steel, however, is likely to rise as the industry introduces new, high-quality steels and expands into other markets.)

While new technologies invariably require energy for their operation, they will generally not be energy-intensive and will have lower energy requirements than existing technologies. Computers, for example, will require electricity, but many of their applications such as control of heating and ventilating systems and industrial processes, will save significant amounts of energy. New communication technologies will lower costs and permit more people to communicate over longer distances more often, but the additional energy requirements will be small. On the other hand, some new technologies for environmental protection may be energy-intensive.

In short, new technologies will not lead to the large increases in energy demand that previous technologies of the industrial era have had. It is very unlikely that the impact of the automobile or the jet aircraft will be replicated in the next decade and a half.

Many new technology applications will depend heavily on electricity. The major growth areas in the future are expected to be in information and communications technologies, both of which are almost entirely dependent on electricity. The production of new materials will require a high degree of temperature control for which electricity is ideally suited. Many industrial process changes which would be adopted for environmental reasons are electricity-intensive. (In the pulp and paper industry, for example, newer mechanical pulping processes, which are being introduced partly for environmental reasons, use significantly more electricity than older chemical processes but have much lower steam requirements.)

At the same time as electricity-using applications continue to grow, steam and heat requirements will be lowered in many uses, partly because of the greater use of electronic control equipment. The result is that electricity will account for a steadily expanding share of end-use energy demand in the years ahead.

Micro-electronics and computers will be at the forefront of broad-based technological advances. One major example is the "smart-power chip" applied to electrical motors. By enabling motors to be run at variable speeds matching the work they are required to do (instead of just 'on' or 'off'), the smart-power chip can cut electricity consumption by as much as 40 per cent. Electric motors account for about half of all electricity use.

However, a caution is in order. Technological improvements are not necessarily adopted even if they are cost-effective as well as technically effective. In many cases, their adoption can depend as much on effective promotion, favourable consumer attitudes, or timing with respect to the replacement of capital stock. The importance of these considerations in specific markets is discussed below in Section 3.

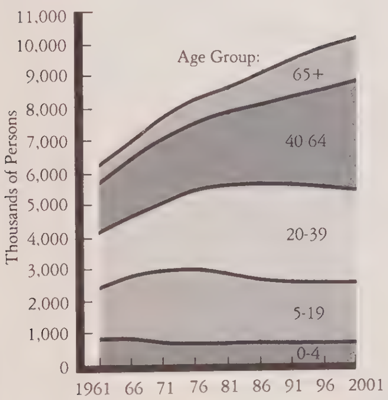
Demographic Factors

The key demographic factors which will influence the economy and its requirements for energy are:

The total size of the population. This influences the demand for housing space, automobiles, household appliances, other consumer goods and services, and public services. Virtually all of the energy-using infrastructure is affected.

The age and sex distribution of the population. This affects the number of working people, household size and earnings, savings rates (young people spend more and save less), tax revenues and consumer spending patterns. The changing demographic profile influences the organization of economic and social life and ultimately, the requirements for energy in all its forms.

Ontario Population



Population Growth and Demographic Change

In the last twenty years, the birth rate in nearly every developed Western nation has dropped dramatically, and Canada is no exception. Demographic shifts are a key force of change in our economy, and though in most cases their effects are felt gradually over a long time period, they are no less significant for it.

By the year 2000, Ontario is expected to have a population of some 10.1 million people, about 1.2 million more than in 1984. Population growth will slow from about 100,000 additional people each year in the mid-eighties to only 50,000 people a year in the late nineties, as a result of fewer births and lower net migration to Ontario. This lower growth will place a constraint on the potential growth of the economy in the nineties.

This prospect contrasts sharply with the situation in the fifties and sixties, when the additional demands of an average 155,000 more people a year fuelled economic growth of over 5 per cent a year and the construction of factories, roads, schools, hospitals and homes to serve the growing population.

Population Structure

The structure of the population will be different in important ways, many of them the result of the aging of the baby boom generation born between 1945 and 1965.

- The number of births will continue to fall, as the baby boomers move beyond peak child-bearing years.
- Children of school and university age will also be fewer in number, although the major impact on schools, colleges and universities has already been felt.
- The population of working age will expand and will mature — the median age of the population will increase from 31 to 37 years.
- The most dramatic change will be in the number of elderly people: there will be 1.4 million people over the age of 65 by the end of the century, or one person in seven (compared to one in nine today).

The effects of the changing population will be widespread. Fewer people in the family-forming 20-39 age group and smaller families will shift the demand for housing toward townhouses and apartments. Growth of Ontario's labour force will slip from 2 per cent to under 1 per cent a year, despite increasing female participation rates. There will be fewer new workers from young age groups, and earlier retirement will become more popular. More services for the elderly will be needed.

Variation in the Outlook

This demographic outlook is unlikely to change significantly, because the major forces affecting population fifteen years ahead are relatively predictable.

- The average number of children born to each woman in her lifetime has fallen to around 1.65, and shows no signs of an increase that would herald another baby boom.
- The death rate is expected to continue to trend downward. Lower infant mortality will be the major factor, while older people will also live longer as a result of improved medical treatment and healthier lifestyles.

The major source of uncertainty in the outlook is the net number of people moving into the province. Interprovincial migration is hard to predict because it fluctuates with the relative prosperity of the provincial economies. For example, the outflow of some 30,000 people a year from Ontario to Western Canada in the late seventies has been dramatically reversed since 1982. Overseas immigrants to Canada, about half of whom choose to come to Ontario, have been reduced in number in recent years as a result of high unemployment rates and the 1975 Immigration Act. Bearing these factors in mind, the net number of people migrating to Ontario could be around 30,000 a year in the base outlook.

A scenario with an easing of immigration restrictions could see a doubling of net migration to 60,000 people a year, which would add some 350,000 people to Ontario's population by the year 2000. This higher population is incorporated in the high energy demand scenario.

The Changing Economy

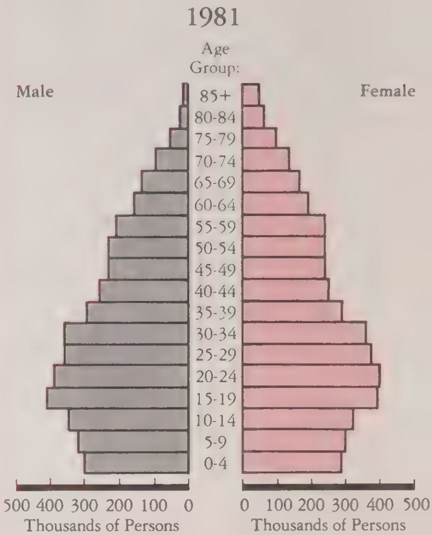
Energy requirements are shaped in a major way by economic circumstances. What we produce, how much we produce, what we choose to consume and what we trade with other jurisdictions exert a major influence on the quantity of energy we need and the forms in which it is required.

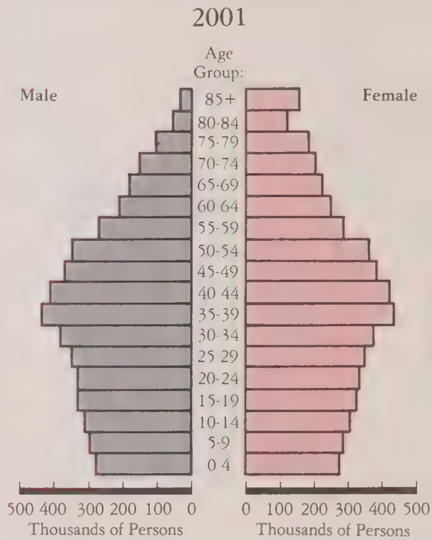
The Importance of Trade

Ontario is a trading province and depends on success in trade for a large part of its economic growth. Approximately a quarter of Ontario's output is exported. Trade with the United States, of which automobile trade is, and will likely remain, the largest part, accounts for 78 per cent of the province's exports.

The trend in international trade is for the industrialized countries to move towards high-value, specialized manufacturing, utilizing high-technology, advanced materials and a skilled workforce. Resource production and manufacture of basic heavy industrial products, such as non-specialized steel and basic petrochemicals, is shifting towards producers with advantages of

Ontario Population by Sex and Age





Importance of Exports in Energy-Using Industries

The five largest energy-using industries all show significant dependence on export trade.

Percentage of Ontario's Industrial Energy Use (1983)

Iron and Steel	30
Pulp and Paper	19
Industrial Chemicals	8
Non-ferrous Metals (including Mining)	6
Automobiles and Parts	5

Exports as a Percentage of Total Shipments (1981)

Iron and Steel	20
Pulp and Paper	61
Industrial Chemicals	52
Non-ferrous Metals (including Mining)	80
Automobiles and Parts	76

The Shift from Manufacturing to Services

	Per Cent of Total 1984	2000
Goods-Producing Sectors	40	36
Service Sectors	51	57
Government	9	7
Total All Sectors	100	100

low-cost labour and access to raw materials. The challenge to Ontario, and to Canada with its large base in resource industries such as primary metals, pulp and paper, and lumber, is to remain competitive in the face of challenges from both advanced industrialized competitors and newly industrializing countries.

Success in this challenge will depend partly on factors outside Canada's control, such as the growth of the U.S. economy, world trade expansion aided by tariff and trade barrier reductions, and international interest rates. Success will also depend on Canada's and Ontario's own ability to capture opportunities. New investment, increased productivity, and competitive labour costs will all be important in this competitive world.

Many of the key industries in export trade are also the major energy users in Ontario. Future energy demand will therefore be affected very greatly by the performance of these industries in the face of international competition.

The Shift to Service Activities

Future energy demand will be shaped by changes in the economic structure. As the economy grows, the greatest expansion will take place in 'service' activities rather than goods-producing activities. This reflects the fact that as incomes rise, people tend to spend more on such activities as information services, travel, leisure pursuits and restaurants, and less on manufactured goods such as heavy appliances and furniture. It also reflects the tendency of basic goods-producing activities to be performed abroad, as described above. The composition of Ontario's economic output will therefore continue to shift toward the production of services — a move which will tend to lower the overall requirements for energy.

Economic Outlook

The base economic outlook adopted for this report is for the Ontario economy to grow an average 2.7 per cent a year from 1984 to 2000. The recent strong growth is expected to continue in the 1985-90 period, led by exports and domestic consumer purchases. In the early 1990s, a slowdown is projected, due in part to a normal, cyclical downturn of the economy, and in part to an increase in the world price of oil. Subsequently, the economy is expected to return to a moderate growth path which reflects its underlying potential for labour force growth and productivity gains.

The base case projection thus contains a healthy outlook for the Ontario economy to the year 2000, consistent with a slowly growing labour force, improved productivity and falling unemployment rates. By the year 2000, total real output is forecast to exceed the 1984 level by 54 per cent, total employment to expand by 26 per cent and per capita real disposable income to be over 18 per cent greater.

There are circumstances which could lead to a much slower growth for Ontario's economy. These include poor performance in the U.S. and foreign economies, widespread resort to protectionist trade policies, and a continuing loss of cost-competitiveness by Canadian industry. **In such a low-growth scenario** Ontario would fare worse than the rest of Canada because of the weak prospect for industrial trade, and the economy would expand by only 27 per cent by 2000.

It is, of course, possible that a much more favourable growth environment would prevail. Internationally, this would require pro-growth macroeconomic policies in the developed countries, a more liberalized world trading environment, and sharply lower interest rates. Domestically, growth would be stronger if labour productivity grows more rapidly, the workforce is augmented by greater immigration, and a favourable trade agreement is reached with the United States. Under these circumstances, a **high-growth scenario** could see the Ontario economy as much as 82 per cent larger by 2000.

Economic Growth Scenarios

	Growth of Ontario Economy, 1984-2000	
Scenario	Total	Annual Rate
Base outlook	54%	2.7%
Low economic growth	27%	1.5%
High economic growth	82%	3.8%

These three scenarios for economic growth are combined with the scenarios for energy prices to form the basis for our three energy demand outlooks, as described in Section 1.

Energy Demand Outlooks

	Assumptions for:	
Outlook:	Economic Growth	Energy Prices
Base Outlook	Base	Base
Low Demand	Low	High
High Demand	High	Low

ENERGY USE IN THE YEAR 2000

The shape of Ontario's energy demand at the end of the century will be fashioned both by the broad forces of economic, demographic and technological change discussed in Section 2 and by particular changes in the many different end-uses of energy. This section takes an in-depth look at these end-uses — in homes, buildings, transport and industry — and explains how changes in these markets could affect our energy future.

Residential Energy Use

Overview

In the year 2000, the total amount of energy used in all the homes in Ontario will be less than in 1984. This may appear surprising, given that there will be 13 per cent more people and nearly one million more houses and apartments, while many more people will own freezers, air conditioners and other energy-using appliances.

The explanation lies principally in the enormous savings that can be made in home heating. These will result from low energy new homes such as the R-2000 house, the insulating and sealing of older homes, and from high-efficiency heating systems such as condensing furnaces and heat pumps. In addition, new housing units will tend to be smaller, (because of rising housing costs and smaller family size) and thus will need less heat. Household appliances will also be more energy-efficient.

Altogether, the average Ontario home in 2000 could use one-quarter less energy than its counterpart today. The saving in energy bills could be substantial.

Big changes are taking place in the housing market which will affect Ontario's energy needs. If total residential energy use is thought of as the total number of homes (houses, apartments and other dwellings) multiplied by the average amount of energy used in each home, then the key question is:

> Will the energy needs of a growing number of homes swamp the energy savings achieved by conservation in each individual home?

To examine this question involves looking at the type of homes that are being built, structural changes in both new and old homes, technical improvements in heating systems, and the energy required for all the other equipment of a modern household: air conditioning, water heating, lights and appliances.

The Number and Type of Homes in 2000

The number of new homes being built today is half what it was 12 years ago. Although some increase is likely from the present rate of about 50,000 a year, the number of new homes being built will fall well short of past levels simply because the population is not growing as fast as it did. The result is that in 2000 only a quarter of the homes in Ontario will have been built since 1984; in fact the majority of homes will date from before the first energy 'crisis' in 1973. Consequently, when it comes to saving energy, improvements in older homes will be at least as important as better design and construction of new homes.

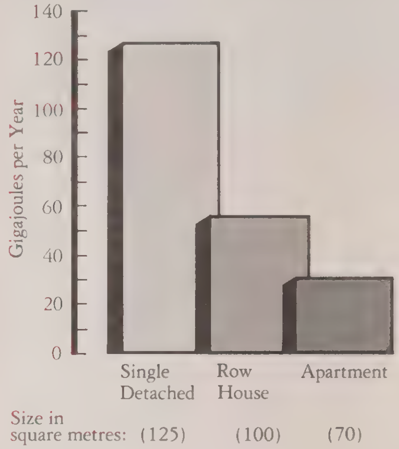
An important trend in new housing is the increasing proportion of townhouses and apartments. Because of smaller floor area and fewer exterior walls, a townhouse requires less than half as much energy for heating as an average single-detached house. An apartment needs less than one third as much. This trend alone will help to cut Ontario's total home energy needs by some 3 per cent by the year 2000.

The expected shift towards apartments and townhouses stems from both demographic and economic factors. Families are expected to remain small as a result of continued low birth rates and single-parent families. The average Ontarian will be older and perhaps more attracted to low-maintenance apartment living, and the number of senior citizens will increase significantly. The high cost of land in urban areas will favour high-density housing. As a result, 60 per cent of the 900,000 new homes expected by 2000 are likely to be apartments, duplexes, semi-detached or row houses. The proportion of single detached houses in the total housing stock is projected to fall from 57 to 53 per cent.

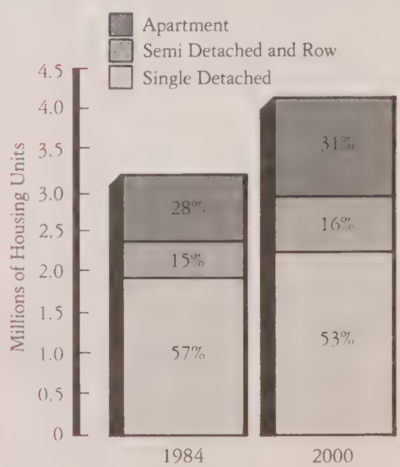
Where Energy Can Be Saved

The most dramatic savings in the home can be made in heating needs. Currently two-thirds of the energy used in homes is for keeping the interior space warm in winter. (The other one-third is for water heating, cooling and appliances, where the potential savings are smaller.) Heating needs can be cut in two principal ways: by improvements to the building structure and by better heating systems.

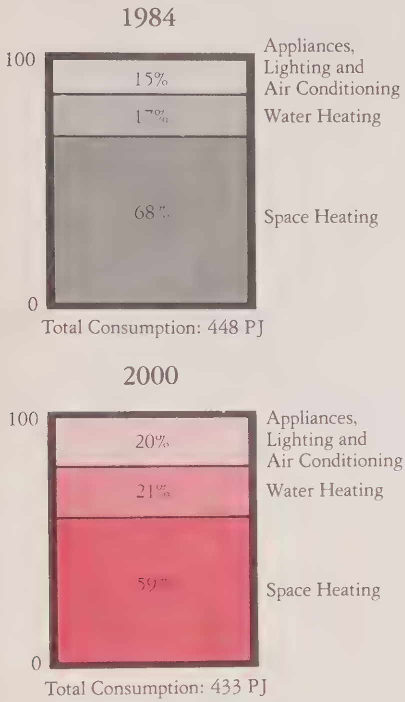
Heating Needs of Different Homes (1984)



Ontario Housing Stock (1984 and 2000)



Energy Use in Homes
(1984 and 2000)



Structural Improvements in New Houses

New, energy-efficient housing construction has the potential to save enormous amounts of energy. Today's standard building-code house uses significantly less energy than the house of ten years ago. However, even higher levels of energy efficiency are now cost-effective, and many builders are adopting new low energy house designs.

Canada's R-2000 program has gained international acclaim for developing and promoting the construction and purchase of low energy house designs. These designs use twice the insulation of standard building code requirements, have double or triple-glazed windows, and are as air-tight as possible to stop warm air leakage. The largest windows face south to catch the sun, fresh air ventilation is ensured by heat recovery ventilators, and a carefully installed vapour barrier avoids condensation in the walls. **These low-energy house designs can reduce heating costs by as much as 75 per cent,** with the result that heating bills can be around $200 for a small house, or $450 for a 3000 square-foot house.

Currently, costs of R-2000 homes run 5 to 10 per cent above similar conventional designs, and this is the main obstacle to their marketability. However, the price gap is expected to narrow as builders gain more experience, and lower energy bills can go a long way toward offsetting higher mortgage costs. Other features which buyers of R-2000 homes find attractive are low noise, freedom from drafts, and less dust, all of which will help to enhance their sales appeal.

The very best of new houses in 2000 will actually be more energy-efficient than the R-2000 house being built today. **Total heating costs can be cut to under $100 a year in current prices, as much as 90 per cent less than the cost for the average house today.**

These houses represent the best that technology can provide. The savings that are actually achieved will depend on how many people purchase low energy houses. Sales will probably be higher with lower interest rates, because the extra cost of energy-efficient features will be easier to bear in mortgage payments. However, the main effect on sales is likely to come from effective promotion and heightened awareness of the advantages of buying an energy-efficient home.

Taking into account the fact that many houses will be built with less than the maximum energy efficiency, **the average new house in 2000 could be over 30 per cent more energy-efficient in the building structure alone than the average of all houses today.**

Structural Improvements in Existing Houses

Improvements in existing houses will focus on simple, low-cost measures that reduce warm air leakage to the outside. Caulking of gaps, weatherstripping around windows and doors, and sealing the sill plate between basement and main walls are major methods. Microchip-controlled thermostats will cut back the heat when it is not needed.

Major improvements will be made in older houses that are renovated, through adding insulation and air sealing. Although the Canadian Home Insulation Program (CHIP), which provides grants of up to $500 for insulating homes built before 1977, will end in 1986, the benefits of insulating attics, walls and basement walls should continue to be attractive for many homeowners.

As a result of such structural improvements, owners of existing single-detached houses could cut their heating costs an average of 20 per cent by 2000, despite the outlook that fuel costs will be stable or rising only slightly. Even if energy prices fall, as projected in the high-demand outlook, the financial savings from low-cost conservation measures will remain considerable.

Home Heating Systems

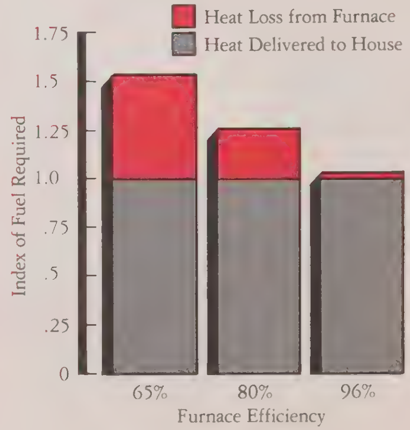
One of the greatest potentials for reducing home energy consumption is in improved heating systems. Natural gas, electric, oil and wood-fired systems have all been improved enormously in recent years.

High-efficiency gas furnaces with improved burners and flue-gas condensers can convert as much as 96 per cent of the energy in the fuel into usable heat. The heat that was formerly lost up the chimney is reclaimed by condensing the exhaust gases and redirecting the heat to the house. Standard furnaces have also been improved by such features as spark ignition systems that avoid pilot light losses, and automatic flue dampers. At present, the condensing gas furnace costs some $800 to $1,400 more to install than a standard furnace, but the savings on heating bills can recover these costs in 4 to 7 years.

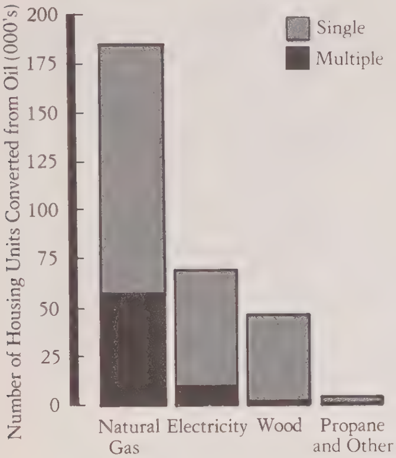
As competition brings the prices of high-efficiency furnaces down, as market acceptance improves, and as old furnaces are replaced when they wear out or break down, the average efficiency of natural gas furnaces in Ontario houses is expected to rise to around 80 per cent by 2000, up from 65 per cent today.

The new generation of oil furnaces is also much more efficient than its predecessors. Flame retention burners and condensing oil furnaces are now on the market. For homeowners who do not have access to natural gas, these offer an alternative to electrical, propane or wood heating.

Fuel Savings from More Efficient Furnaces



Off-Oil Conversions in Ontario (1981-85)



The federal government's Canada Oil Substitution Program (COSP), which has helped 300,000 Ontario homeowners to convert from oil since 1981, ended in March 1985. However, the price of home heating oil is expected to stay relatively high compared to natural gas and electricity. There are still some 700,000 homes in Ontario heated by oil. Consequently, off-oil conversions will remain attractive and will continue, though at a slower pace than under the COSP program. **By 2000, less than 500,000 Ontario homes are expected to be heated by oil.**

Electric heating offers a wide variety of different systems, such as baseboard heaters, plenum heaters, and heat pumps, that are especially attractive in new houses with highly energy-efficient designs. In fact, the very best houses built in 2000 will be kept warm and comfortable with only a 3 kilowatt electric heating system.

Electric heat pumps are more expensive than other heating systems, but they have one big advantage: they can provide summer cooling for the whole house as well as winter heating. This feature, together with reduced capital costs, is expected to help heat pump sales increase to the extent that they could heat 4 per cent of all homes by 2000.

Hybrid heat-pump systems, which use oil or natural gas backup for the coldest days, have not been as popular as expected, perhaps because of their complexity and higher capital cost. However, design improvements in the standard air-source heat pumps and the advent of vertical-hole, ground-source heat pumps — which extract heat from the earth and deliver energy to the house with three times the efficiency of resistance heating — will continue to make heat pump systems attractive.

Electric heating is expected to capture about half of the total new home market (houses and apartments) in the 1985-2000 period. By the year 2000, about 23 per cent of all homes will be heated by electricity. Of course, if oil and natural gas prices fall relative to electricity prices (which is the case in the low-price scenario), electric heating will become less attractive, but the expected range of price changes should not affect the market share of electricity by more than 1 or 2 per cent.

Improvements in Apartment Buildings

New apartment buildings will also benefit from increased insulation, airtightness and other low-energy design features. Heating systems will be improved in both old and new apartment buildings. However, the gains will not be as dramatic as in houses because apartment heating needs are already lower. In large apartment buildings a great deal can be done with improved energy management systems, including heat recovery systems and controls to prevent wasted heat.

ENERGY USE

Total Heating Requirements

Considering the combined effects of improvements to building structures and better heating systems, an average house in 2000 could need about 30 per cent less heating fuel than today, while an apartment might use about 24 per cent less.

Water Heating

The amount of energy used for water heating varies enormously with people's lifestyles. Showers, baths, dishwashers and washing machines can take a great deal of hot water, on average about 17 per cent of home energy needs. In future, the efficiency of water heaters will improve as a result of better equipment and more insulation on the tank. The improvements are expected to average only about 8 per cent, however, not as great as the improvements in space heating.

Home Appliances

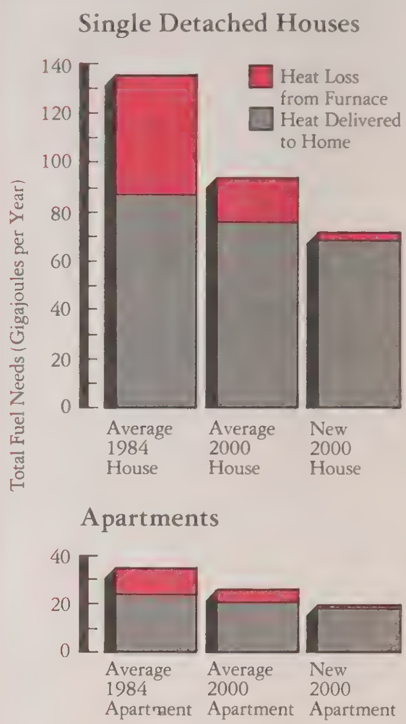
Home appliances — refrigerators, stoves, dishwashers, televisions and other equipment, including lights and air-conditioners — currently use about 15 per cent of all the energy used in the home. This percentage is likely to rise, because appliance ownership and use will expand by more than enough to offset efficiency improvements. Rising incomes will allow two-thirds of households to own freezers and clothes dryers, for example. Efficiency improvements are hard to estimate in aggregate, but it is projected that the average efficiency of appliances will improve by around 15 per cent by 2000.

While the market for many appliances is becoming "saturated" (that is, the average home already has at least one) there will continue to be new products on the market. Fortunately many of them will be low energy users. Video recorders, microwave ovens and microcomputers for the home do not use much energy. In addition, the designs of traditional appliances such as refrigerators, freezers, dishwashers, and clothes dryers will be improved. These factors will counterbalance the increased appliance use that will come with growing incomes and leisure-oriented lifestyles. For example, while the total ownership of dishwashers is expected to more than double, their efficiency is expected to increase by 40-50 per cent, so that the total energy they use will rise by only 60 per cent.

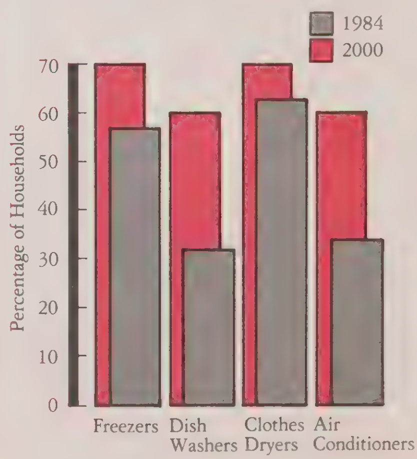
Air Conditioning

Air conditioning is expected to be found in 60 per cent of homes in 2000 — roughly double the percentage today. There will be more homes using central space-cooling systems, as well as the more common window-type air conditioners. The total energy use by air conditioners will not be

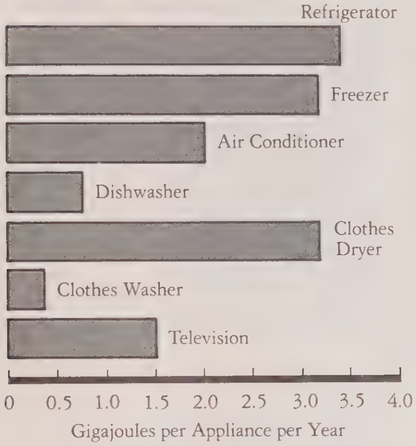
Energy Savings in Home Heating (Natural Gas Heated)



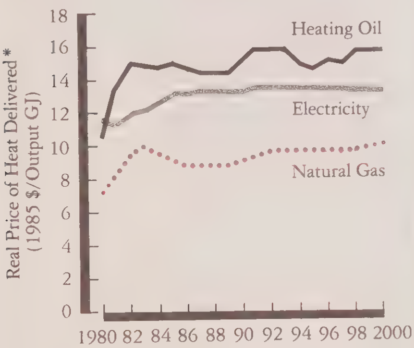
Ownership of Major Appliances



Energy Use by Different Appliances (1984)



Residential Heating Energy Prices



* Energy delivered from heating oil and natural gas is based on assumed furnace efficiency of 65%; electricity is based on 100% efficiency

large, because of the relatively low number of heat-wave days in Ontario, but they will contribute to peak electricity needs in summer.

Total Home Energy Needs

Combining all the home energy needs — heating, hot water, air conditioning, lighting and appliances — **the average home in 2000 will need only three-quarters of the energy used in 1984.** This saving will be more than enough to offset the energy needs of 900,000 more homes. As a result, Ontario's total home energy requirements are expected to be lower in 2000 than today.

Residential Energy Demand by End Use

	1984		2000	
	PJ	%	PJ	%
Space Heat	303	68	254	59
Water Heat	75	17	91	21
Appliances, Lighting, Air Conditioning	70	15	88	20
Total	448	100	433	100

Higher energy prices would increase the incentive for buying low-energy homes and for improving present homes, but there is sufficient incentive in the base price outlook for homeowners to take advantage of the improvements that are available today. Lower prices such as those in the low-price outlook would curb the incentive somewhat, but unless there is a dramatic collapse in oil prices and consequently natural gas prices, the financial benefits of saving energy in the home will continue to be attractive.

It appears that under a fairly wide range of scenarios, total home energy demand in 2000 will differ very little from today's level.

Residential Fuel Shares

Homeowners will continue to reduce the use of heating oil. Out of total residential energy needs in 2000, only about 9 per cent will be met by oil, a far cry from 31 per cent in 1980.

Electricity consumption is expected to grow by 18 per cent over the period in the base outlook. Part of this growth will come from increasing popularity of electric heating systems, and part from increased use of electrical appliances.

Natural gas will still dominate the home heating market but its total use is not expected to rise. There could be some 600,000 more homes heated by natural gas, but greatly increased efficiency of new furnaces and boilers will offset larger numbers of gas-using equipment. This continues a

trend of relatively static natural gas demand that has been evident for several years.

Wood for home heating will grow moderately. Where wood is cheap or easily accessible, in rural and semi-rural areas, it will remain an attractive alternative to oil. In urban centres, its higher cost and concern for safety and the environment will limit its popularity. However, some urban homes will use wood for supplemental heat or for aesthetic reasons. Unlike the traditional open fireplace, which is a net heat-loser, a well-designed fireplace insert can effectively displace some of the main heating fuel.

Residential Energy Demand by Fuel

	1984 (PJ)	2000 (PJ)	% Change 1984-2000
Oil	74	40	−46
Natural Gas	231	220	− 5
Electricity	126	149	+18
Wood, Solar and Other	17	24	+41
Total	448	433	− 3

Energy Use in Commercial and Institutional Buildings

Overview

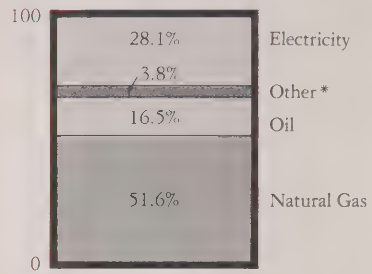
Offices, stores, hotels and other commercial buildings will be expanding as Ontario's growing economy continues to emphasize service activities over heavy industry. The need for information, communication and leisure services will be particularly strong. On the institutional side, there will likely be little or no increase in the school age population. The total number of school buildings may therefore remain unchanged from present levels. However, there will be an enlarged need for health care facilities as the number of senior citizens grows.

On balance, the amount of space in commercial and institutional buildings could be some 40 per cent greater by the turn of the century. However, energy requirements will grow at only about half this rate.

New buildings are already being designed to use energy more efficiently and this trend will continue. Older buildings will be refurbished as the need arises and will most likely include energy-saving

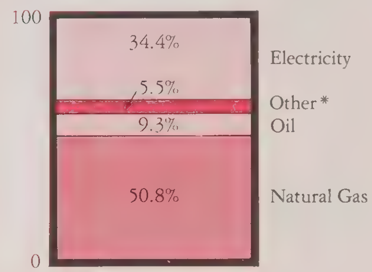
Residential Fuel Shares (1984 and 2000)

1984



Total Consumption: 448 PJ

2000



Total Consumption: 433 PJ

* Wood, Propane, Solar, Coal

features. Consequently, the energy needed to heat, light and operate these buildings where we work, shop, learn and play will be used more sparingly.

However, the pace and timing of investment in energy conservation is by no means certain, since it will depend largely on the economic climate. If these investments are accelerated, the savings will make it easier for businesses in the service sector to provide jobs for some two-thirds of the province's work force by the year 2000.

Commercial and institutional buildings include offices, schools, hospitals, stores, hotels, restaurants and warehouses, to name just a few. The services provided in such buildings create income and jobs for over three-fifths of Ontario's work force. Energy use in support of service activities is therefore immensely important.

The Sources of Commercial/Institutional Growth

The trend to a service-oriented economy in Ontario will continue. **Eighty per cent of the more than 1 million new jobs that will be created by the year 2000 will be in the service industries,** particularly those involving business and information services and the hospitality industry.

Although it has been suggested that electronic communication and personal computers will allow more people to work at home instead of in offices, the social and organizational advantages of a common workplace will probably remain paramount. It is unlikely, therefore, that the need for offices and commercial space would be reduced on this account. Office space per employee could increase somewhat, as more equipment is used. Ontario's share of national office building space will probably remain around 50 per cent.

Shorter work weeks, more leisure time, greater incomes and small families will cause recreational equipment and services to be the fastest growing component of consumers' expenditure. As a result, more stores, theatres, sports centres, hotels, tourist facilities and restaurants will be opened. Commercial warehouse construction should also increase to serve the growing retail market.

Building space devoted to offices, hotels, and restaurants is expected to grow by more than 60 per cent in the 1984-2000 period.

On the other hand, the growth of institutional buildings — schools and churches in particular — is expected to be limited. New facilities will be built in areas of population growth, but there will be closings and conversions to other uses in areas of declining population.

The lack of growth expected in school, college and university buildings is a simple consequence of demographics — facilities built for the baby boom are more than sufficient for the children to come in the rest of this century and beyond. In fact, only smaller class sizes in schools and greater enrolments in higher education will stop educational building needs from falling in total.

The elderly (65 and over) population will increase by more than 40 per cent by the end of the century. This will create great pressure for more hospital and nursing home facilities. However, there are other ways of providing care and shelter for the elderly. By means of increased use of home care, out-patient treatment, and sheltered apartments for seniors, the expansion of health care facilities could be perhaps two-thirds of the growth in the elderly population.

In total, it is estimated that commercial and institutional buildings will have 43 per cent more space in 2000 than today. Almost half of this stock will have been built since 1980, providing ample potential for improved energy efficiency.

Where the Energy is Used

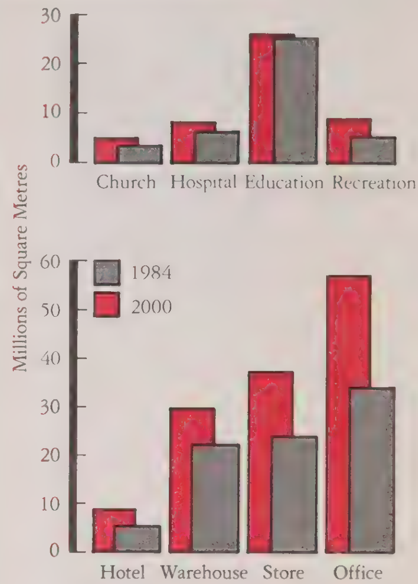
Two-thirds of the energy used in the commercial sector is for heating and cooling buildings. Heating will remain the largest energy user, but the fuel required per unit of space will decline as a result of increasing levels of insulation and the installation of improved heating systems. By 2000, space heating in these buildings is expected to be about 20 per cent more efficient. Combined heating and cooling systems using heat pump chillers are becoming increasingly popular.

Lighting systems are also being made more efficient, both by reducing the amount of lighting in places where it is not essential, and by improved equipment that needs less electricity to produce the same amount of light.

On the other hand, there is likely to be an increased demand for energy for cooling and equipment use. Nearly all new buildings provide air conditioning or cooling systems. As older buildings without air conditioners are renovated or replaced, cooling needs will increase their share to 5 per cent of total energy use. Increased use of electrical equipment including computers, business machines, fans and pumps will give rise to small increases in energy needs.

Overall, these changes are likely to improve the average efficiency of energy use by some 15 per cent by 2000.

Floor Space in Commercial and Institutional Buildings



Energy Uses in Commercial and Institutional Buildings (GJ per square metre per year)

	1984	2000	% Change
Space heating	1.29	1.03	−20
Water heating	0.06	0.05	−17
Lighting	0.28	0.24	−14
Space cooling	0.07	0.08	+14
Fans, pumps and other equipment	0.28	0.28	0
Total	1.98	1.68	−15

Potential For Energy Efficiency

The opportunity to improve energy efficiency depends on many factors including the age of the building, the state of the economy, fuel prices and the type of activity carried on in the building.

Clearly, new buildings designed from the start with energy efficiency in mind offer the greatest potential for savings. To achieve the same kind of improvement in old buildings usually requires a major renovation, although it is surprising how much can be achieved by good energy management practices and improvements to existing energy-using systems.

A steadily expanding economy will encourage energy efficiency, particularly if interest rates are low. Not only will new construction proceed faster than in a slow-growth situation, but existing buildings will be improved as businesses find the capital necessary to undertake renovations.

The ways in which energy efficiency can be improved include building structure improvements, new technologies in energy-using systems, and changes in building operations.

Building Structure Improvements

New buildings constructed in 2000 could use as much as one-third less energy than the average for buildings erected before 1984. Much of this improvement will occur as builders more widely adopt energy-efficient construction practices such as reflective glass, high levels of insulation, airtight construction, and sophisticated air conditioning equipment and temperature controls.

New Technology

New technology in heating systems will play a big part in lowering energy use and costs.

Condensing gas boilers, which are more efficient than traditional boilers, will be increasingly used in both new buildings and retrofits of old buildings. Ground source heat pumps and water-source heat pumps (such as

the installations at Valley East near Sudbury and the Terminal Warehouse in Toronto) are also expected to gain wider acceptance as they become more cost-effective.

A recent survey indicated that 30 to 40 per cent of large commercial buildings are now being built with heat recovery, and this trend is expected to accelerate. Internal zone systems recover heat from zones that require cooling and transfer it to zones that require heating. Diurnal systems recover heat generated during the day and store it for later use. Air-to-air systems use the warm air being ventilated outside to heat incoming air.

Thermal storage has been highly economical in new, large buildings such as Hydro Place in Toronto. This technology uses large volumes of water to store the heat generated in the building by sunlight, indoor lights, machines and people. A sophisticated control system then distributes the heat to where it is needed. Hydro Place is an outstanding example of energy efficiency, using about 0.6 GJ of energy per square metre per year. Such systems, however, are less economical in smaller buildings, and are unlikely in existing buildings because of their high capital cost.

Energy management systems will be more widely employed to cut electricity peak use and to control lights, heating systems and air-circulation fans. Often the savings in lower fuel bills and operating costs are enough to pay for the installed system within a year.

Building Operations

The type of building, its use and hours of operation are all critical factors determining the extent to which energy conservation is possible.

Hospitals, for example, are in use on a 24-hour basis, have high energy requirements for surgical lighting, equipment and hot water and must be kept warm for patients' comfort. Their energy needs will therefore remain the highest of all the categories of buildings in this sector.

Churches use a significant amount of energy for heating whether they are occupied or not, and aesthetic considerations in religious buildings add to the difficulty of making energy-reducing changes.

On the other hand, **education buildings** have already achieved significant energy savings, and a relatively small additional improvement is foreseen for this group. School boards, colleges and universities have made great strides in cutting total energy use and in converting off oil since the mid-seventies. Further improvements are possible but many would require significant capital expenditure.

The potential for conservation in **retail stores** is quite high but varies with the type of store. Supermarkets, for example, use roughly twice as much energy per square metre as shopping centres, because of high refrigeration and lighting needs. Good lighting of displays is essential in

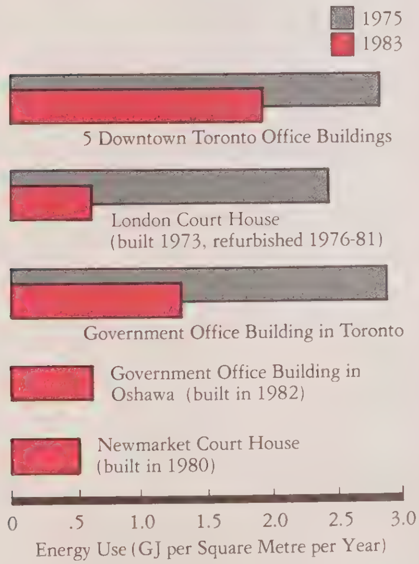
retail stores, and so savings are more likely to be achieved by more efficient lighting than in lower lighting levels.

Office buildings can save a great deal of energy when designed from scratch to be energy-efficient, as the examples below show. In large buildings there is a symbiotic effect in that lower lighting levels generate less unwanted heat and thus lead to lower cooling requirements. On the other hand, the fact that many offices are rented and energy costs are a small part of total costs can reduce the incentive for conservation.

Commercial and Institutional Buildings Average Energy Use (GJ per square metre per year)

	1984	2000	% Change
Institutional			
Education	1.2	1.1	− 8
Hospitals	3.2	2.7	−16
Religious Buildings	2.1	1.9	−10
Miscellaneous Buildings	2.8	2.3	−18
Commercial			
Offices	1.5	1.3	−13
Stores and Garages	2.1	1.7	−19
Hotels	1.5	1.3	−13
Recreation	2.3	2.0	−13
Warehouse	1.2	1.0	−17
All buildings	2.0	1.7	−15

Some Energy-Efficient Buildings in Ontario



Examples of Energy Efficiency

A good example of high-efficiency new construction is the government office tower opened in Sudbury in 1980. Its original design, considered to be very energy-efficient in 1976, was modified to include additional energy-saving features such as overhangs above each window, added heat pumps, thermal storage, solar energy to heat water, and computer-controlled equipment to manage the energy load. The tower uses only 0.5 GJ of energy per square metre per year, about one-fifth less than the original design level.

Older buildings constructed before the major energy price rises can also be improved. The London courthouse, built in 1973, is a good example of how energy can be saved in older buildings lacking many of today's up-to-date energy conservation features. By lowering the inside temperature at nights and on weekends, reducing lighting levels, adjusting the air-conditioning and hot water equipment and changing the mechanical systems, a 75 per cent reduction in total energy requirements was achieved. Today, the courthouse uses 0.6 GJ of energy per square metre annually and compares favourably with much newer buildings.

Many other examples could be given, some of which are shown on the chart. The savings achieved in a group of downtown Toronto office buildings—29 per cent in the last decade—are a good example of low-cost improvements which did not require major capital investment.

Commercial/Institutional Fuel Shares

The use of oil has been declining steadily under the influence of large price increases and government off-oil programs. Recent oil substitution projects in municipal buildings assisted by the Ministry of Energy, for example, have had paybacks of less than two years. **Unless oil prices decline substantially, which is not foreseen, the financial incentive for oil substitution will remain attractive over the next fifteen years.** Thus, it is likely that oil's share of energy requirements will fall to around 5 per cent by the end of the century.

Natural gas will remain the principal heating fuel over the next decade and a half. Currently, it is much cheaper than oil and will capture much of the off-oil market. However, it will face increased competition from electricity, particularly in newly constructed buildings.

Although electricity is more expensive than oil and gas on a per gigajoule basis, its efficiency is much greater in large centralized heating, ventilation and air conditioning systems. Electric systems are more likely to capture a larger share of the market, particularly in the 1990s. By 2000, electric systems will heat 13 per cent of the floorspace built before 1985, and at least one-third of new construction. Electricity, of course, will continue to provide nearly all the energy needs for lighting, cooling and equipment use.

Commercial/Institutional Energy Use by Fuel

	1984 PJ	1984 %	2000 PJ	2000 %
Oil	52	14	25	6
Natural Gas	199	54	237	53
Electricity	116	32	178	40
Solar and Other	—	0	3	1
Total Energy	367	100	443	100

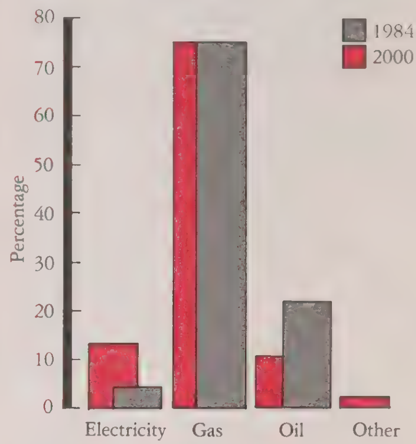
Total Energy Use

Total energy needs in commercial and institutional buildings are expected to be 21 per cent higher in 2000 than in 1984.

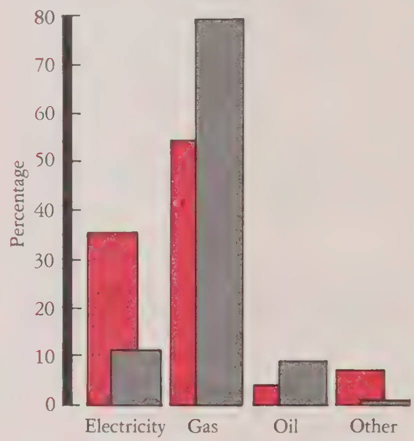
This outlook would change if the economy grows faster or slower than predicted in the base outlook. However, the commercial/institutional demand for energy is less likely to vary from the base outlook than industrial

Fuel Shares for Space Heating

Buildings built up to 1980



Buildings built after 1980



or transportation demand. (Institutional building needs in particular will not be greatly affected by the economic outlook). Variations of about 10 per cent more or less from this base outlook would occur in the high and low energy demand scenarios.

Transportation Energy Use

Overview

Gas guzzlers are a vanishing breed, victims of technology, consumer preference and high energy prices. The majority of them have already been replaced by smaller, lighter, and more aerodynamic cars which are much more fuel-efficient. Even if no further improvements are made in fuel economy, the full replacement of older cars would lead to a substantial reduction in the average car's fuel requirements. It is likely, however, that improvements will continue to be made in automobiles, and the new car at the turn of the century could be 15-20 per cent more efficient than those produced today.

Car ownership in Ontario, already among the highest in the world, will continue to increase. People will travel more — both within Ontario and abroad — as their incomes increase. Despite this, Ontarians will be using less energy for automobile and airline transportation.

On the other hand, larger volumes of freight will need to be moved as the economy expands, and since opportunities to raise efficiency in bulk transportation may be limited, much more energy will be required for shipping goods than is the case today.

Although some gasoline will be replaced by alternative fuels such as propane and methanol blends, transportation will remain over 90 per cent dependent on oil products. In effect, six out of every ten barrels of oil used in Ontario at the turn of the century will be required solely for transportation uses.

Where the Energy is Used

Transporting people consumes six-tenths of Ontario's transportation fuels today. The automobile is by far the most frequently used means of transport, and accounts for over 90 per cent of the passenger kilometres travelled. Aircraft, trains, buses, subways and streetcars account for the rest. Car ownership in Ontario is among the highest in the world, having

grown from 28 cars for every hundred people in 1961 to 45 per hundred today. **By the end of this century, Ontario could have 50 cars for every hundred people, or a total of five million automobiles.**

The use of the automobile is unlikely to decrease, because it provides transportation for leisure, business and commuting purposes. Although Ontario has the highest usage of public transit in Canada (18 per cent of Ontario commuters use transit today), the automobile is, and will remain, the primary mode for travel to work.

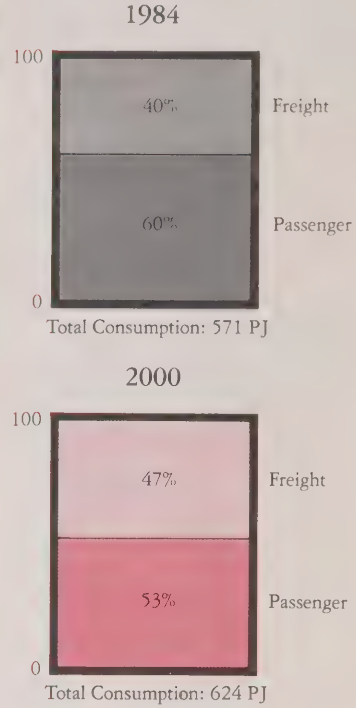
Moving goods and commodities consumes the remaining four-tenths of transportation fuels. Bulk commodities such as iron ore and coal from the U.S. and grain from the Prairies use marine transport. Others such as forest products from Northern Ontario depend largely on rail. General freight shipments, which are smaller in volume, go by rail, truck and marine modes. Short-haul urban freight relies almost entirely on trucks. Although large-volume rail and marine shipments are much more energy efficient, they cannot compete with trucks for lower-volume, short-haul and local service. The result is that even though rail and marine accounts for most of the volume of freight shipments, trucks account for the vast majority of the fuel used in freight transport.

Transportation: Where the Energy is Used

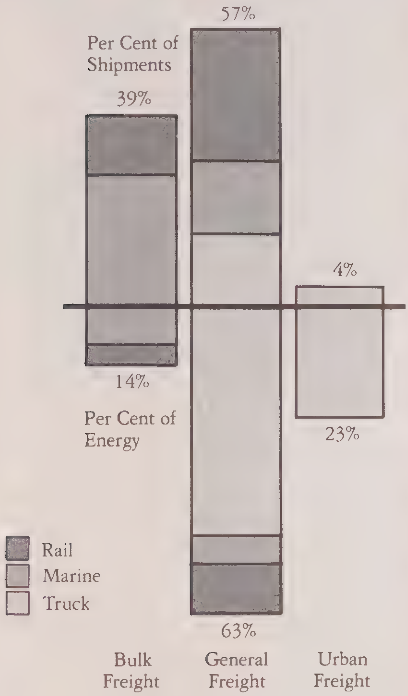
	Per Cent of Fuel Use 1984	2000
Passenger Transport	60.0	52.8
Automobile	50.9	43.5
Aircraft	7.1	6.9
Buses	1.3	1.5
Trains	0.4	0.5
Streetcar, Subway, LRT	0.3	0.4
Freight Transport	40.0	47.2
Marine	5.1	6.0
Rail	4.4	5.0
Truck	30.5	36.2

By 2000, total annual demand for transportation fuels is projected to increase by about 9 per cent from the 1984 level, or just over 0.5 per cent per year. The volume of passenger travel and freight transport will grow by 29 and 32 per cent respectively over this period. However, increases in the fuel efficiency of cars, airplanes and to a lesser extent, trucks, will contain the growth in fuel use.

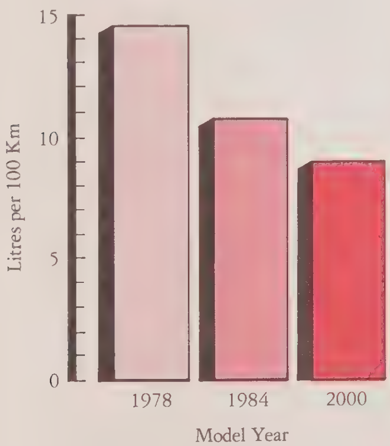
Energy Use in Transportation (1984 and 2000)



Energy Shares in Freight Transportation (1984)



Fuel Consumption in New Cars



Automobile Efficiency

Gasoline use is projected to decline from over 400 PJ in 1984 to about 350 PJ in 2000. This will occur even though the number of automobiles registered is expected to increase from less than 4 million to about 5 million. The reduction in gasoline use can be attributed in part to the substitution of alternative fuels for gasoline and a greater proportion of diesel-engined cars in the automobile fleet. However, the major factor will be continued improvement in automobile fuel efficiencies.

There has already been remarkable progress in improving fuel efficiency. Spurred by sharply higher fuel prices, consumers and automobile manufacturers reversed the trend of the 1960-75 period toward larger, heavier and gas-hungry cars. Legislated U.S. fuel economy standards, increased imports of small cars and technological improvements have all contributed to this change.

Even if there were no change in new car efficiencies from the 1984 standard, the fact that newer automobiles are continually replacing older, less efficient cars would result in a 19 per cent gain in fleet fuel efficiency by the year 2000.

Further technological changes will continue to improve new car fuel economy. Some of these are being introduced now, such as greater reliance on micro-processor engine control, fuel injection, and more aerodynamic body shells. Other changes such as extensive use of light composite materials for body panels, ceramic engines, and variable-ratio automatic transmissions may take longer to become industry standard.

However, much of the easily obtainable and most cost-effective technological improvements have already been incorporated into the 1985 automobile models. **Additional fuel economy in the years to come will be at higher cost to both the consumer and the manufacturer.** This fact, combined with the outlook for little or no growth in the real price of refined petroleum products for the next few years, makes it likely that future efficiency improvements will occur at a slower pace than in the recent past. In a scenario with significantly higher oil prices, of course, these improvements would be introduced more rapidly and extensively. The converse is true if oil prices were to decline in real terms.

When the stock turnover is combined with some of these technological improvements, the effect on vehicle efficiency is very significant. **The average gasoline-powered car in 2000, it is estimated, will use only 9.3 litres per hundred kilometres. This represents a 29 per cent improvement on the average of 13.1 litres per 100 km. today.**

Diesel Use in Freight Transport

Trains, a large majority of trucks and some marine vessels use diesel engines. Consequently, as freight shipments expand with economic growth, so will the demand for diesel fuel.

Largely because of its predominance in freight transport, diesel fuel use could increase by about 50 per cent by the year 2000. About three quarters of the increase will come from greater freight shipments, the balance coming from increased automobile use of diesel.

There is less scope for efficiency improvements in diesel-powered equipment compared to gasoline-powered vehicles. Rail locomotives and marine vessels are major capital items with effective lifetimes of twenty years and longer. The slow turn-over in capital stock, and the small savings in fuel costs compared to the cost of retrofitting or replacement, inhibit large or rapid changes in the overall efficiency of these modes.

Trucks have an effective life of 5 to 10 years, comparable to that of automobiles. Although there has been some improvement in diesel engine efficiency, and many intercity trucks have adopted the new generation of diesels, the take-up of these improvements by some segments of the trucking industry has been uneven.

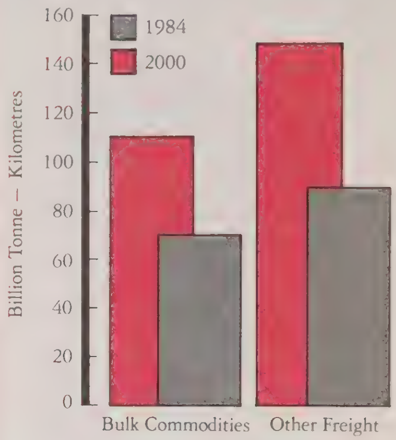
Behavioural changes will probably contribute more to diesel fuel saving than technological changes. Driver training and increased awareness of the financial savings from fuel conservation, more effective and rational routing of shipments, higher load factors, and elimination of regulatory restrictions on trucking routes are examples. However, the adoption and timing of these "institutional" changes in the trucking sector are uncertain. As in the automobile sector, real increases in diesel fuel prices would accelerate such changes; declines in price would inhibit them.

Airlines

The airline sector will likely show steady growth in passenger demand. Both business and personal travel will grow as the economy expands, incomes rise and tourism grows. This is expected to be offset by efficiency improvements in the aircraft fleet and, as a result, **no increase in aviation fuel demand is expected in the years ahead.**

The potential for improving airline fuel efficiencies is large. However, significant capital investments are required and these will depend on robust and steady airline industry cash-flows. The 1982 recession and its aftermath severely affected the financial performance of the airline industry, with the result that planned purchases of the new generation of fuel-efficient airliners have been reduced or postponed.

Freight Shipments



As in the trucking industry, some types of regulatory changes may allow airlines to operate more fuel-efficiently by dropping low seating-density routes and rationalizing schedules. Technological improvements in new aircraft, such as the use of composite materials to save weight, turbo-fan jets, and two-engine instead of three or four-engine designs, may also contribute to lower fuel consumption.

Alternative Fuels

Alternative transportation fuels have grown in importance since the late 1970s. From no market at all in 1979, propane use in transportation has increased to about 6 PJ in 1984, with over 60,000 vehicles using propane on Ontario's roads.

Propane will continue to be an attractive fuel, particularly for the fleet operator. Its cost advantage over gasoline should remain despite the removal in 1985 of the federal $400 grant for propane conversion. However, the traditional competition from gasoline will intensify as oil prices remain constant or decline in real terms in the next few years. In the longer term a steady increase in propane use is expected, to the extent that demand could triple by 2000.

Methanol-blended gasoline was introduced into the Ontario market in mid-1985. This fuel has been extensively tested and has been gaining consumer acceptance in the United States, which increases the likelihood that it will penetrate the Canadian market significantly. In addition, methanol's quality as an octane enhancer makes it an attractive alternative to lead in meeting more stringent emission standards. In the base case outlook **it is estimated that half of all the gasoline sold in Ontario in 2000 could contain a 10 per cent methanol blend** (actually 5 per cent methanol and 5 per cent co-solvent).

Natural gas for vehicles (NGV, also known as compressed natural gas) has the potential to replace significant amounts of gasoline in the short-haul urban market. Aggressive marketing by gas utilities and demonstration fleets have shown that NGV can be a viable substitute for gasoline or propane in some applications. Additional research and development is necessary to optimize the on-road performance and reduce the cost of compression and refuelling facilities.

Electric-powered vehicles are not expected to make any significant impact before the year 2000, as a major breakthrough in battery technology would be required to make them an attractive alternative to gasoline.

Total demand for alternative transportation fuels is projected to be 46 PJ by 2000 in the base case, or almost 8 per cent of total transportation demand. If oil prices are high, as in the low energy demand scenario, total

alternative fuel use could rise to 56 PJ, while if oil prices are low, it could be around 34 PJ. The range could therefore be from 5 to 10 per cent of total transportation energy use, depending on oil prices, with methanol blends the greatest contributor by 2000.

Transportation Fuel Shares

Among the oil based fuels, consumption of diesel is projected to grow more than 50 per cent by 2000, but this will be offset by a 12 per cent decline in gasoline consumption. The total demand for oil in transportation would therefore remain essentially unchanged.

The use of alternative fuels as substitutes for gasoline is expected to grow substantially, particularly in the use of methanol in blends and propane. Electricity use in streetcars and subways will also increase, but will remain a small fraction of total transportation energy.

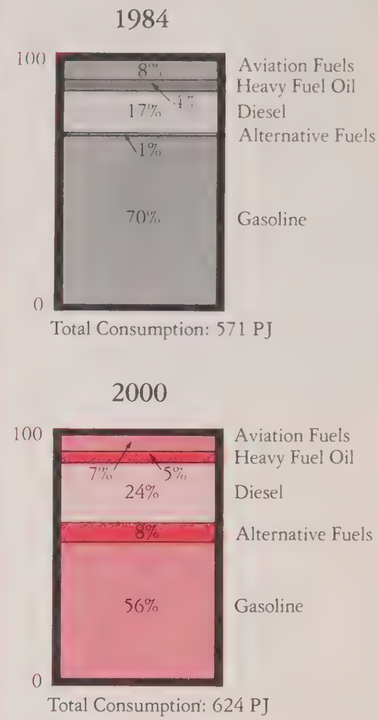
Transportation Energy Use by Fuel

	1984		2000	
Oil Based	PJ	% of Total	PJ	% of Total
Gasoline	398	70	350	56
Diesel	95	17	148	24
Aviation Fuels	48	8	43	7
Heavy Fuel Oil	22	4	34	5
Alternative Fuels				
Propane	6	1	17	3
Methanol	–	–	23	4
Natural Gas	–	–	6	1
Electricity	2	–	3	–
Total	571	100	624	100

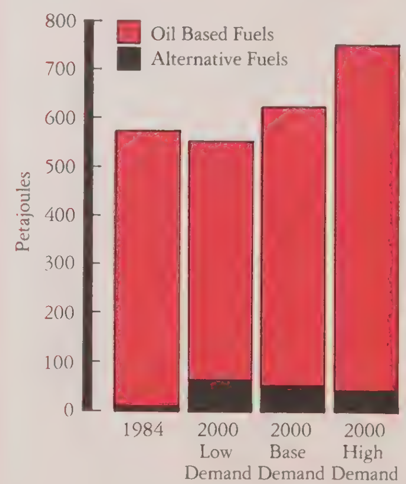
Total Transportation Demand

The total demand for transportation fuels is expected to grow by some 9 per cent in the base outlook for the year 2000. In the low-demand scenario, the vulnerability of freight transport to slow economic growth implies that transportation fuels demand could actually fall from current levels. On the other hand, in a high-growth scenario with low prices, freight growth and greater automobile sales could push total demand up by as much as 32 per cent from current levels, despite improved vehicle-efficiency.

Transportation Fuel Shares (1984 and 2000)



Transportation Fuel Demand



Industrial Energy Use

Overview

The industrial base is an enormous source of income and jobs in Ontario. A large portion has been established on resource extraction and upgrading and petrochemical production. While this kind of structure does provide great benefit, it exposes some of our major industries to intense international competition. Furthermore, it calls for large amounts of energy for its viability and it is vulnerable to increases in the cost of fuel and power.

There is a strong imperative for Ontario's industries to invest in technology. If such investments are made both in broad-based technologies and in specific energy-efficient technologies, industrial growth can be sustained without corresponding increases in energy use. Moreover, since technological change is generally biased in favour of electricity-using equipment and devices, it is anticipated that Ontario's industries would become increasingly dependent on electrical power in order to secure productivity gains and markets at home and abroad.

Industrial Energy Uses

Energy is used in industry for a wide variety of applications. The most important are steam production, direct heat, motive power and chemical feedstock.

The three largest users of energy are the iron and steel, pulp and paper, and industrial chemicals industries, which together account for over half the energy used by all industries. Industrial chemicals include ethylene as well as ammonia, chlorine, and other basic chemicals.

The oil-based petrochemical industry, dominated by the Petrosar complex in Sarnia, is the major industrial user of oil. Other "non-energy" uses of oil (where oil is used for its chemical rather than energy content), include lubricants, waxes and asphalts.

The Changing Industrial Structure

There are two major and opposite trends in industry affecting Ontario's energy use. First, the industries that produce hard goods—the manufacturing and resources sectors—will grow more slowly than the economy as a whole in the 1984-2000 period. This will tend to slow the growth in energy use. Second, within the goods-producing sector, the greatest growth is expected to be found in the major energy-using industries.

How Industries Use Energy Today

Indirect Heat (30%)
— use of steam raised in boilers

Direct Heat (25%)
— often for higher temperature uses such as metal melting

Motive Power (17%)
— to drive electric, steam or internal combustion motors

Utilities (7%)
— space heating, ventilation and lighting

Electrolysis (1%)
— electrochemical processes such as aluminum and chlorine production

Petrochemicals and Chemical Feedstock (13%)
— to produce ethylene and other building blocks for petrochemicals, ammonia for fertilizers, etc.

Non-energy Uses (7%)
— lubricants, waxes, asphalt, etc.

The result of the second trend is that in a favourable international environment (such as envisaged in the base outlook), production of iron and steel, pulp and paper and industrial chemicals could expand by 35 to 70 per cent by 2000. This growth among the major energy users would almost entirely offset the improvements in energy efficiency made throughout industry. Consequently, average energy use per unit of industrial output could fall, but only by 3 per cent by 2000.

The Outlook for Key Energy-Using Industries in Ontario

Iron and Steel

By 2000, steel production could be some 50 per cent greater than in 1984. This projection depends crucially on the industry's success in maintaining access to foreign markets and combating import competition at home, and on continued strong demand for steel by the auto industry. Specialty steels will be important growth areas.

Technological Changes

Under the impact of intensive foreign competition, the North American iron and steel industries are modernizing their production processes and products. Some changes are being implemented rapidly. For example, all major producers are moving into electrolytic galvanizing to supply the auto industry for the 1987 model year. Other changes are further away. For example, the commercial application of "thin-slab" steel casting technology may be almost a decade away.

Open hearth furnaces, which accounted for almost one-quarter of steel-making capacity in 1976, will be replaced by 2000. Most replacement capacity will be **basic oxygen furnaces** which do not require a supplemental heat source; thermal energy comes from the oxidation of carbon and other impurities in the pig iron.

In the early 1990s, **plasma arc technology** may be introduced in some blast furnaces. This technology produces an extremely hot (3000 degree Celsius) ionized gas by passing an electric current through it. Adoption of plasma arc would lead to significantly lower coke requirements per tonne of steel and much higher electricity use. However, the technology is as yet unproven in large scale operations with the high reliability requirements of the steel industry, and its capital cost may be high. If these problems with the technology are solved by the early 1990s when major replacement of coke oven capacity is expected, enough plasma arc capacity could be installed to raise the steel industry's electricity demand significantly. However, since its technological readiness and cost are still

Technological Changes in Industry

Several types of technological change will affect the energy use of more than one industry. Microelectronics, which was discussed in Section 2, is an excellent example. Some other technological changes are described below:

Advanced Materials

Considerable research is underway to produce lightweight, strong, heat resistant materials for a large number of applications. The two main approaches are the production of lightweight, liquid crystal polymers, including ceramics, and ion-beam processing. A number of stronger, smoother, flexible and more heat resistant materials have been produced by both methods. Full scale commercial application will require improved technologies, proven large-scale production techniques, and improved economics. If such barriers are overcome, the impact could be quite significant on the demand for metals. Ontario is a large producer of ferrous and non-ferrous metals.

Membrane Technologies

Membrane technologies can reduce energy requirements dramatically for separation processes. They utilize the property that mixed fluids can be separated by migrating differentially across a membrane under the influence of an electric charge, concentration or pressure. Membrane technologies include reverse osmosis, electrodialysis, ultrafiltration and gas separation. They offer enormous thermal energy savings, and improved recovery, for fluid separation processes that currently rely on energy-intensive distilling. Industries where these separation processes are widespread include the food and beverage, pulp and paper, and industrial chemicals industries. Currently, membrane technology is being applied in producing industrial chemicals, but there is a large potential use in other industrial sectors.

Heat Pumps

Heat pumps, the most common example being the domestic refrigerator, work by using electro-mechanical energy to transfer heat from one place to another by alternately compressing and vaporising a fluid (refrigerant). Large units in the 10 to 20 MW range are increasing in use in other countries. It is anticipated that heat pumps will be applied in drying, heating and heat recovery in industries such as pulp and paper, food and beverage, textiles and chemical products.

Fluidised Bed Combustion

Fluidised bed combustion shows great promise as a means of reducing acid gas emissions from combustion. In this technology a fuel such as coal is burned in an agitated bed of inert particles that are kept suspended and in turbulent motion by using forced air or oxygen. Limestone, introduced into the bed, absorbs 90 per cent of the sulphur in the fuel, and the resulting slag can be removed. In addition, nitrous oxide emissions are reduced because the combustion temperature is lower. As this technology improves, industries may find coal an acceptable alternative to oil and gas.

Plant Automation

Many Canadian companies still have no automated equipment, and only 40 per cent have some computerized factory components. However, substantial increase in plant automation investment is likely, with producers of primary metals, electrical machinery, and heavy machinery taking the lead. Automation will increase the use of electricity but the overall impact on energy use will be small compared to much larger productivity gains.

Just-in-time Inventories and Processes

New approaches to inventory control and the management of manufacturing processes significantly reduce plant and warehouse space needs, scrap products and machine down-time. This is true for both supply companies and their customers. These new approaches can be expected to spread rapidly and promise significant net energy savings in manufacturing enterprises.

uncertain, no significant uptake of plasma arc is anticipated in our base outlook.

Market Factors

Steel production capacity is in worldwide surplus at present, and the growth of Ontario's iron and steel industries could be weakened by several factors. Among the threats are renewed protectionism in the U.S., loss of cost-competitiveness versus foreign suppliers, and a general decline in world trade. Steel is also facing competition from other materials, such as aluminum for cans and plastics for lightweight automobile components.

Despite these market threats, the base case outlook is for a 50 per cent growth in steel production. However, the range of uncertainty is quite large. In a low energy demand scenario only a 10 per cent growth could occur, while in a high demand environment steel output could expand as much as 90 per cent by 2000.

Energy use in the steel industry will follow production growth fairly closely. Some efficiency gains are expected, largely from new technologies, but significant energy efficiencies will be constrained by the fact that the capital stock lasts for many years in this industry.

Pulp and Paper

The demand for newsprint, fine paper and other paper products will continue to expand with the information age. Production is forecast to grow by 37 per cent by 2000, and energy needs by 32 per cent. The industry has almost achieved its conservation target of a 30 per cent efficiency gain relative to 1972.

The thermo-mechanical pulping (TMP) process is expected to continue to replace chemical pulping for new capacity because of its higher yield and much lower environmental impact. The TMP process consumes more electricity but can save on fossil fuels, particularly if heat pumps are used to recover waste heat.

The pulp and paper industry has been a leader in conserving scarce energy resources, making maximum use of the wood waste and spent pulping liquor that are produced during pulp and paper manufacture. These sources should continue to make up over half of the fuel used by the industry.

Automation and micro-chip technology also offer scope for improvements in project management and productivity. Add to this the improvements in waste re-cycling, and it is very likely energy efficiency gains will continue to be made, although not as large in percentage terms as in recent years.

Industrial Chemicals

The industrial chemicals industry produces large-volume, basic chemicals such as ammonia, chlorine and ethylene which are essential inputs to the manufacture of chemical products such as fertilizers, polyvinyl chloride and plastics. Natural gas is a major feedstock for the industry.

The industry is highly intensive in capital and technology and long lead times are required for capital projects. Ontario's industry has internationally competitive technology. Hence, wholesale revamping over the next decade or so is unlikely.

Energy costs for fuel and feedstock account for the major portion of total chemical production costs. Not surprisingly, therefore, the industry has achieved one of the biggest percentage gains in energy efficiency of any major energy-using industry (27 per cent over the past decade). The industry will continue to improve efficiency by installing advanced control systems which monitor and control the temperature, pressure, and rates of reactions.

Production of industrial chemicals is expected to grow strongly — by 70 per cent by the year 2000 — reflecting healthy growth in domestic and international demand for downstream chemical products. Although energy efficiency is expected to improve in each component of the industrial chemicals sector, total energy use is forecast to increase by 76 per cent in the base outlook. This is the result of high growth expected in ammonia production.

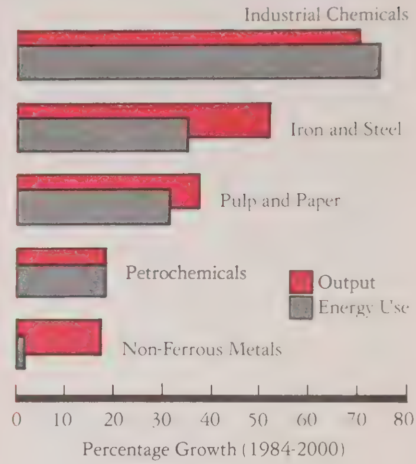
Ammonia capacity in Ontario will increase by 50 per cent in 1985 with the start-up of the new highly efficient C-I-L plant in Courtright. Ammonia, which is used to produce fertilizers, is extremely energy-intensive as it depends on natural gas both as a fuel and as its chemical feedstock. Natural gas accounts for seventy per cent of the industry's costs. Whether the output of ammonia will grow in line with the new capacity will therefore depend both on the growth of demand for fertilizers and on competition from other ammonia producers whose natural gas costs differ from those in Ontario.

New capacity for chlorine production will use energy-efficient membrane cells instead of diaphragm cells. Electricity requirements would be similar, but steam requirements would be virtually eliminated. Energy savings of up to 50 per cent can be obtained.

Petrochemicals

Energy use by the Petrosar petrochemical complex is projected to grow by almost 20 per cent by 2000, by greater use of existing capacity. To be competitive a petrochemical producer must be able to use a variety of feedstocks. Petrosar is planning capital investments which will allow it flexibility in the use of oil-based or natural gas liquids as feedstock.

Outlook for Major Industries



Oil use is expected to decline sharply as these capital investments start to pay off. By the late 1980s at least half of Petrosar's feedstock requirements could be met by natural gas liquids.

It is worth noting that although petrochemical production is energy-intensive, many downstream products of the petrochemical industries replace more energy-intensive products. For example, less energy is used to produce plastic bags than paper bags, including the energy content of the material.

Typical Energy Content of Petrochemicals and Competing Products

Container	Materials	Total Energy (GJ)
Half gallon bottle	PVC plastic	12.9
	Glass	27.1
Gallon produce bag	Low Density Polyethylene	.5
	Paper	.6
Gallon oblong container	High Density Polyethylene	17.0
	Steel	21.4
Gallon milk container	High Density Polyethylene	7.9
	Paper	7.6
8 oz. dairy tub	ABS plastic	2.0
	Aluminum	6.1
9 oz. vending cup	High Impact Polystyrene	.6
	Paper	.3

Note: Energy content includes both the energy used in manufacture and the energy contained in feedstock materials.

Source: The Society of the Plastics Industry of Canada.

Non-Ferrous Metals

The non-ferrous metals industry, of which nickel, copper and zinc are the most significant in terms of energy use, is recovering from its toughest time since the 1930s. As investment increases to maintain competitiveness in international markets, there is potential for greatly increased automation of mining, and improvement in smelting and refining technologies for energy and environmental reasons. Significant energy efficiency improvements can be achieved in copper smelting, where newer technologies can halve energy requirements, including the energy needed for environmental control.

There are factors such as automation, the need to dig deeper mines, and lower-grade ore bodies, which tend to increase energy use per tonne of product. On balance, however, energy efficiency is expected to increase.

In nickel smelting, a significant possible change is a switch to the use of electricity in place of fossil fuels. This could result from tighter environmental regulations rather than from economic reasons, since the capital cost and energy requirements are high. If electric furnaces are introduced, they could add about one per cent to the province's total electricity requirements by the end of the century, thereby displacing coal and natural gas.

Fuel Shares in Industry

Oil will continue to lose market share to natural gas, electricity and coal. The cement industry, for example, has already switched largely from oil to coal in recent years. The lime industry is switching to coal, and the pulp and paper industry is making extensive use of wood waste, coal, and electricity as more electricity-intensive processes are adopted. Large chemical and primary metals companies are also considering increasing their use of coal. Many of these changes are the result of shifts in relative fuel prices that have already occurred. Should oil and gas prices rise sharply in the next decade, the trend toward electricity, coal and renewable energy sources would become even more pronounced.

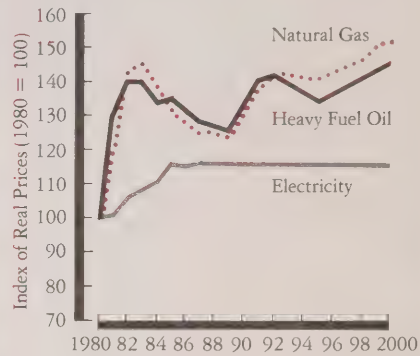
Refinery closings and upgradings will accelerate the off-oil switch as the production of heavy fuel oil (the major petroleum product used by industry) is reduced. By 1990, oil will supply only 10 per cent of industry's fuel requirements (excluding petrochemical and other non-energy use), down from 17 per cent in 1980. This is noteworthy because sectors such as construction, forestry and agriculture are almost completely dependent on oil. Oil use as a petrochemical feedstock will fall. Despite major growth in industrial output, therefore, total oil use in industry will increase only marginally.

Natural gas use by industry is expected to increase by 90 PJ, a 30 per cent growth. However, its share of total industrial use will not increase, despite above-average growth in some gas-using industries and substitution of gas for oil in others. Growth will be restrained by efficiency improvements in natural gas furnaces and boilers, and by intense competition from coal, wood waste and electricity.

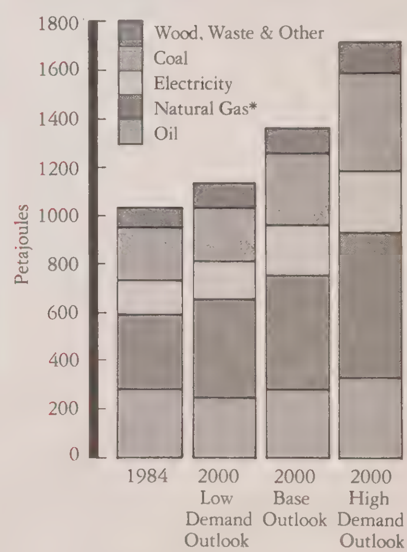
In our base outlook, industrial prices for natural gas and heavy fuel oil will rise more or less in tandem while the price of electricity will be unchanged in real terms throughout the period.

Future coal requirements will primarily be determined by growth in iron and steel production, which accounts for 90 per cent of industrial coal use. Coke is both an energy source and a raw material in this industry. In the second half of the 1990s some of the coke requirements could be replaced by electricity and thermal coal if the plasma arc process is adopted by the industry.

Index of Industrial Energy Prices



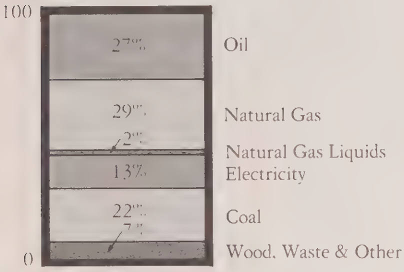
Industrial Energy Demand**



* Includes NGLs
** Includes petrochemicals and other non-energy uses

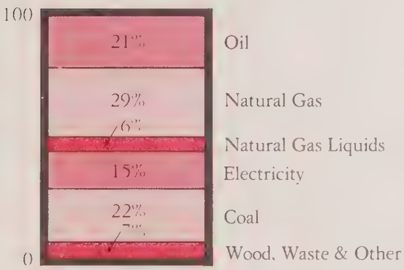
Industrial Fuel Shares (1984 and 2000)

1984



Total Consumption: 1018 PJ

2000



Total Consumption: 1347 PJ

Electricity use in industry is projected to grow significantly, by 50 per cent by 2000. Industrial expansion will become more dependent on electrical energy and less dependent on fossil fuels. The attractiveness of electricity will be enhanced by little or no increase in the real price of electricity and improved technology developments.

Renewable energy use, primarily the use of wood waste and spent pulping liquors in the pulp and paper industry, will continue to expand, thereby reducing the growth in demand for the conventional energy sources.

Industrial Energy Demand Projections

	1984 (PJ)	2000 (PJ) Base	% Change 1984-2000 Low	Base	High
Oil	273	279	− 8	2	19
Natural Gas Liquids	20	84	275	320	415
Natural Gas	296	386	8	30	66
Electricity	137	206	16	50	91
Coal	220	294	5	34	86
Wood, Waste and Other	72	98	28	36	56
Total	1,018	1,347	11	32	67

Note: Figures are for energy used in industrial applications and petrochemicals and other non-energy uses. The large growth in consumption of natural gas liquids reflects the partial switch from oil in petrochemical production.

Co-generation of Electricity in Industry

An important means of increasing the efficiency of energy use is the co-generation of electricity and process heat by industry. In this type of system, the heat energy that is normally wasted in industrial processes is instead used to generate electricity. Any industrial plant with large enough process heat needs can co-generate. If the plant is also connected to the electricity grid, as much of the plant's electricity needs as possible is met by its own generation, with any excess being sold to the grid and any shortfalls made up by purchases from the grid.

The industrial chemicals industry is a leader in co-generation. For example, Dow Chemical in Sarnia uses gas turbines with a capacity of 265 MW to generate electricity for chlorine/sodium separation by electrolysis. The waste heat from the turbines augments boilers that provide steam for process heat.

It has been estimated that there is an economic potential for additional industrial co-generation of some 500 to 1000 Megawatts in Ontario, equivalent to 2 to 4 per cent of Ontario Hydro's present capacity. For the base outlook, a reasonable assumption is that roughly 300 MW of new industrial co-generation could be put in place by the year 2000.

REQUIREMENTS

FUTURE ENERGY REQUIREMENTS

Energy Efficiency

The overall picture of end-use energy demand in Ontario in 2000 is an encouraging one. Aggregating all the energy needs in the four end-use sectors, **total energy requirements are forecast in the base outlook to grow by only 18 per cent by the end of the century or one per cent a year.**

Total End Use Energy Demand by Sector (Base Outlook)

Sector	1984 (PJ)	2000 (PJ)	% Change 1984-2000
Residential	448	433	− 3
Commercial/Institutional	367	443	+21
Transportation	571	624	+ 9
Industrial *	1018	1347	+32
Total End Use Energy	2404	2847	+18

* *including petrochemicals and other non-energy use*

The efficiency of energy use will improve by 23 per cent from its 1984 level, reflecting energy conservation throughout the economy. Efficiency gains are indicated by reduced energy use per dollar of economic output, as the chart of energy intensity shows.

The picture remains remarkably consistent when two alternative — and fairly extreme — possible scenarios are considered. A high energy demand scenario driven by high economic growth and low energy prices could see end-use energy requirements rising by 41 per cent, only half as fast as economic activity. Conversely, a low energy demand scenario caused by low economic growth and high energy prices could see energy use by 2000 as little as 3 per cent above current levels. The total demand for energy could thus vary, but in all three scenarios, the intensity of energy use is expected to decline to about four-fifths of its 1984 level.

Comparison of Alternative Outlooks

Per cent change 1984 to 2000	Low Demand Case	Base Case	High Demand Case
Gross Provincial Product	27	54	82
Total End Use Energy	3	18	41
Level of energy intensity* (1984 = 100)	81	77	78

* *Ratio of End-Use Energy to Gross Provincial Product*

REQUIREMENTS

The greatest savings in energy use will be in home heating and in automobile transportation. Savings will likely be significant in commercial and institutional buildings, while savings in freight transport will be hampered by the relatively low potential for efficiency changes in trucks, trains and ships. In individual industries, energy efficiency will generally improve. In industry as a whole, however, the improvement in energy use per unit of output will probably be only marginal because the energy-intensive steel and chemical industries are likely to remain strong.

Efficiency Improvements by Sector (Base Outlook)

Sector	Indicator of Energy Intensity	Intensity in 2000 (1984 = 100)
Residential	Energy Use/Housing Unit	75
Commercial	Energy Use/Building Floorspace	85
Transportation		
• Passenger	Energy Use/Passenger-Kilometre	71
• Freight	Energy Use/Tonne-Kilometre	99
Industrial*	Energy Use/$ Output of Goods-Producing Industries	97
Total Economy	End Use Energy/$ GPP	77

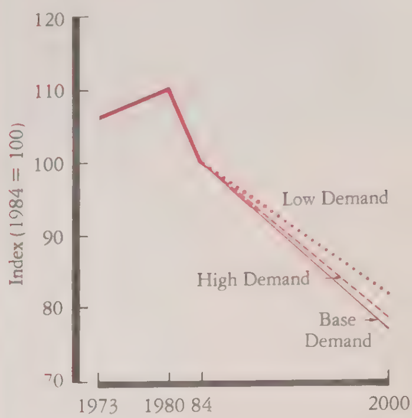
* Including petrochemicals and other non-energy use

The reasons for the increased efficiency of energy use are several:

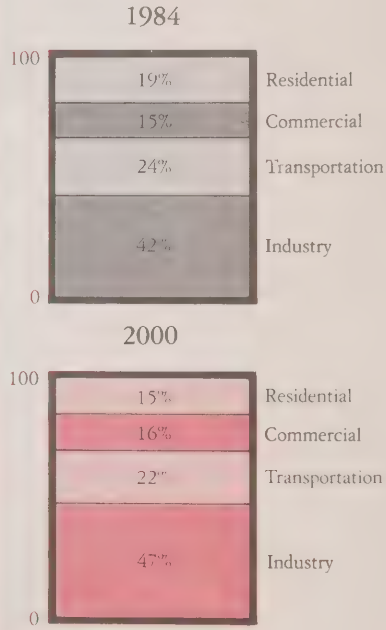
- continued adjustment by consumers and businesses to past energy price escalation;
- a shift in economic activity towards service industries; and,
- adoption of new technologies (many of them developed in response to higher energy prices) that use less energy to produce the same output.

The greatest part of the energy efficiency improvements will be achieved in the next 5 to 10 years, reflecting adjustment to the large 1979-82 price increases. Improvements will continue throughout the forecast period, however, as old capital stock in the form of cars, houses, buildings, and machinery is replaced and as newer industrial processes and technologies become more widespread.

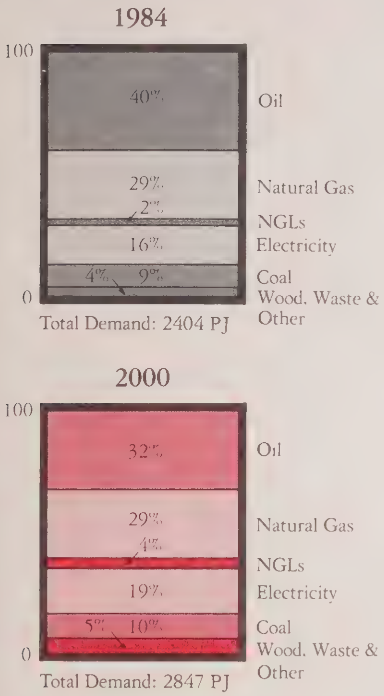
Energy Intensity in Ontario



Energy Market Shares



Energy Fuel Shares



The balance in the mix of energy sources will continue to improve over the period 1984 to 2000, with reduced dependence on oil. (Percentages do not add up to 100 due to rounding)

Outlook for Fuels and Electricity

Oil

Ontario's dependence on oil will continue to fall. Oil's share of total end-use energy will drop from 40 per cent today to 32 per cent in 2000, mainly as a result of substitution of other fuels in heating, greater efficiency of automobiles, and a partial switch to natural gas liquids (NGLs) for petrochemical feedstocks. The total use of oil is forecast in the base outlook to fall by 5 per cent.

Projected Changes in Oil Demand

Sector	1984 (PJ)	2000 (PJ)	% Change 1984-2000
Residential	74	40	−46
Commercial	52	25	−52
Transportation	563	575	+ 2
Industrial Fuel Use	84	102	+21
Petrochemicals	117	78	−33
Non-Energy Uses	72	99	+38
Total — Base Case	962	919	− 5
— High Demand		1129	+17
— Low Demand		770	−20

By 2000, oil will be used largely for transportation (63 per cent), petrochemical feedstocks (9 per cent) and non-energy uses such as lubricants and asphalt (11 per cent). These are the high-value uses of oil where its unique properties can best be utilized: high energy density, transportability, ease of handling as a transportation fuel, and complex hydrocarbon structures which can be used to make petrochemicals and lubricants. Traditional heating uses of oil will be largely replaced, except where it is used as a fuel for industrial boilers, or where other fuels are not available (such as natural gas in certain rural areas).

Oil's future would be slightly brighter in a high demand scenario with low oil prices. End-use oil demand could be as much as 17 per cent higher than today, largely as a result of higher transportation use. The attractiveness of fuel-efficient cars and alternative fuels would be somewhat reduced, while freight shipments would grow significantly in a booming economy. Even in this scenario, however, oil demand would not return to its 1980 level, due to the impact of oil substitution in heating uses.

Conversely, a low-demand scenario with high oil prices could see oil use drop sharply in response to a hesitant economy and greater incentives for alternative transportation fuels.

The falling demand for oil has several implications for the refining industry. The decline in demand will be much less dramatic than in the 1979-83 period. A five per cent demand reduction over sixteen years in the base outlook leaves time for adjustment of refinery capacity, unless there is an increase in petroleum product imports from other countries. Also, the demand for heavy fuel oil and for gasoline will continue to fall, while diesel demand is expected to rise.

Natural Gas

The demand for natural gas is expected to grow by some 17 per cent by 2000, in line with the modest growth rate for all end-use energy. **Natural gas thus will maintain but not increase its 30 per cent share of the total energy market.** That this should occur despite healthy economic growth and continued substitution away from oil reflects the effects of conservation as a result of the price hikes of the 1980-83 period.

In residential markets the consumption of natural gas will be held below 1984 levels by improved energy efficiencies of buildings and of furnaces. Electricity will continue to be a formidable competitor, particularly in the latter 1990s when its price relative to natural gas is expected to improve. In industrial markets, natural gas sales should increase steadily, although coal will continue to take some customers away.

If investments in co-generation facilities prove to be economic, they could significantly increase natural gas use in large industrial plants. In this regard, a key factor would be the price of natural gas relative to other fuels.

Price reductions for natural gas relative to its competitors would be required to ensure the retention of existing customers and capture of new markets. Price cuts should reflect the presence of large surplus supplies in Western Canada.

Projected Changes in Natural Gas Demand

	1984 (PJ)	2000 (PJ)	% Change 1984-2000
Residential	219	209	− 5
Commercial	195	233	+19
Transportation	0	6	–
Industrial	296	386	+30
Total — Base Case	710	834	+17
— High Demand		958	+35
— Low Demand		744	+ 5

The use of natural gas in vehicles (NGV) is not expected to be significant in the overall picture, though some 6 petajoules (enough to fuel 60,000 cars) may be consumed in the year 2000.

In the event of high energy demand and low prices, natural gas use could grow as much as 35 per cent by 2000, largely in industrial applications. Conversely, a scenario of low energy demand and high prices could see natural gas demand stagnate, with an increase of only 5 per cent over sixteen years.

Natural Gas Liquids

A three-fold increase in the use of natural gas liquids (NGLs) is expected by 2000, as the Petrosar petrochemical complex switches half of its production from oil to NGLs and propane use continues to grow in the transportation fuels market.

Demand for Natural Gas Liquids (Base Outlook)

Sector	1984 (PJ)	2000 (PJ)
Residential	12	11
Commercial	4	4
Transportation	6	17
Industrial Fuel Use	5	6
Petrochemicals	15	78
Total	42	116

This outlook depends crucially on the assumption that Petrosar will have the capability to use both oil and NGLs and will remain a viable competitor in petrochemical production.

In alternative outlooks, lower oil prices would reduce the amount of propane used in vehicles, and higher oil prices would increase it, but the overall prospect for NGLs is dominated by petrochemical usage.

Electricity

Electricity use will grow faster than that of all the other major energy forms. Its market share is expected to expand to 19 per cent of end-use energy by 2000, from 16 per cent today.

The projected growth rate of 2.2 per cent a year will be modest, however, compared to both historical rates and to the 5 per cent growth rate experienced in 1983 and 1984. The potential of 3.0 per cent annual growth in the high demand outlook and 1.3 per cent a year in the low demand outlook are useful bounds on the realm of possibilities.

Projected Changes in Electricity Demand

	1984 (PJ)	2000 (PJ)	% Change 1984-2000
Residential	126	149	+18
Commercial	116	178	+53
Transportation	2	3	+50
Industrial	137	206	+50
Total — Base Case	381	536	+41
— High Demand		608	+60
— Low Demand		470	+23

Residential use of electricity will grow much more slowly than commercial or industrial use. Increased efficiency of household appliances, even though there will be more of them, and competition from natural gas for heating, will be the principal reasons.

Electricity has many advantages as an energy form because of its versatility and controllability. Its future role will be far more than just as an alternative to fossil fuels in heating markets. Such uses as microprocessor control of industrial processes, home and business computers, lasers in metal cutting, variable drive electric motors, plasma arc heating, and heat pumps are all examples of the versatility of electricity. It plays a key role in launching new technologies, freeing up time for leisure, eliminating waste and enhancing productivity throughout the economy.

Coal

Coal is used both in industrial end-use applications and in electricity generation.

Industrial uses are expected to rise by about a third by the year 2000, to 294 PJ from 220 PJ in 1984. The demand will be mainly for metallurgical (coking) coal for steel production, and so the forecast depends largely on the projected strength of the steel industry. Because steel output is greatly affected by the health of the economy, the low demand scenario could see industrial coal use increasing by only 5 per cent, while the high demand scenario could see growth as high as 86 per cent.

As new nuclear power stations come into operation over the next few years, Ontario Hydro will reduce the amount of coal used for electricity generation. However, as electricity demand continues to grow, it may be necessary to generate some of the additional power from coal-fired stations in the latter half of the 1990s. Coal use in electricity generation could be some 212 PJ in 2000, down from 345 PJ in 1984. Other options for additional electricity generation are discussed in the companion paper **Fuelling Ontario's Future.**

Wood, Waste and Other Sources

Renewable energy sources (other than hydroelectric power) are projected to make a moderate impact on energy use by 2000. Wood used for home heating and wood waste used by the pulp and paper industry could provide just over 4 per cent of total end-use energy.

Solar energy for heating water in some food industries, laundries and similar applications will make a small contribution. Passive solar energy will help to reduce heating needs in buildings by such features as south-facing windows.

Also included as an 'other' source is methanol, although it is manufactured today from natural gas. Blended with gasoline, methanol is expected to provide just under one per cent of total energy needs by 2000.

CHALLENGES

CHALLENGES AND OPPORTUNITIES

The prospect presented here — of increased energy efficiency, reduced dependence on oil, and a growing market share for electricity — brings with it some risks, but also challenges and opportunities.

The Importance of Investment

One key conclusion is that investments in new energy-efficient capital stock will be required throughout the provincial economy: from home-owners, vehicle owners, businesses and industries. Consequently the climate for investment will be important. Continued steady economic growth will foster investment, while high interest rates, slow growth or unstable international conditions would tend to limit it.

Lack of knowledge of the opportunities for energy saving could also constrain investment. Here governments as well as equipment suppliers have an important role to play — by providing information, funding demonstrations, maintaining awareness of energy conservation, and leading by example in their own buildings and vehicles.

At present there is considerable downward pressure on world oil prices, and the prospect of lower prices presents both opportunities and risks. Prices for oil and other fossil fuels such as those envisaged in the low price outlook would still be sufficiently high to provide incentive for conservation and for substitution from oil to cheaper fuels. The Ontario economy would also benefit from lower costs, less inflation and greater purchasing power retained in the province.

However, a collapse of world oil prices to below the level of the low-price outlook, and perhaps to below $20 U.S. per barrel for an extended period, would be liable to limit energy-saving investments. There would be advantages to Ontario as costs fall, but opportunities would be lost to improve energy efficiency and productivity. The risk in such a scenario is that a collapse of oil prices is not likely to be sustained over the long term. Lower prices, by stimulating demand and reducing supply of oil, would sow the seeds for future price escalation. A failure to invest in energy efficiency and oil substitution would leave the Ontario economy vulnerable.

The importance to Ontario's economy of remaining competitive in international markets has been stressed in this paper. Healthy economic growth will depend on the competitiveness of our resource, manufacturing and high-technology industries. While some of the factors affecting these industries are not controllable — world commodity prices and trade barriers for example — other factors are. Actions which improve energy efficiency will help strengthen competitiveness by lowering industry's costs and enhancing productivity.

A different challenge would arise in the scenario of low energy demand, which would result from high energy prices and low economic

growth. Although Ontario could be using no more energy in 2000 than at present, it would not be the desired objective if energy use were restrained by a sluggish economy instead of by improved efficiency. High prices would provide incentive for energy efficiency investments, but slow economic growth would reduce purchasing power and limit the ability of consumers and businesses to make such investments. As a result this scenario would yield the smallest improvement in energy efficiency of all the three scenarios considered. The challenge in this environment would be to maintain investment even though the economy is growing slowly.

The Outlook for Fuels

The outlook for individual fuels also provides both challenges and opportunities.

Energy Demand Growth, 1984-2000 (End-Use Energy)

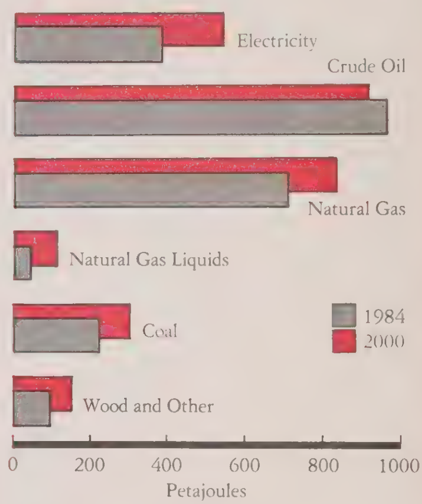
	Percentage Growth Total	Percentage Growth Per Annum
Crude Oil	−5	−0.3
Natural Gas	17	1.0
Natural Gas Liquids	176	6.6
Electricity	41	2.2
Coal	34	1.8
Wood and Other	66	3.2
Total — Base Outlook	18	1.1
— High Demand	41	2.2
— Low Demand	3	0.2

For electricity, the prospect is for an expanding market share and opportunities for increasing applications in high-technology areas. The growth rate of electricity demand, however, will be lower than in the past, and the challenge will be for Ontario Hydro to keep costs and thus prices down.

Natural gas demand will grow, but only by 1 per cent a year in the base outlook. This does not augur well for an industry with surplus supplies looking for markets.

One constraint on natural gas sales is the relative price of gas with respect to competing fuels, especially coal and electricity. A major opportunity for expanded sales exists by lowering natural gas prices. A challenge also exists for the natural gas industry to promote improvements in the technologies for gas use — as in the case of domestic furnaces, for example — and to expand to new uses such as the transportation market.

Energy Demand Growth by Fuel



Energy Demand Growth (1984-2000)

	1984 (PJ)	2000 (PJ)
Crude Oil	962	919
Natural Gas	710	834
NGLs	42	116
Electricity	381	536
Coal	220	294
Other	89	148
Total — Base	2404	2847
— High Demand		3395
— Low Demand		2478

The prospect for oil is for declining use in heating markets, and little increase in the transportation sector. The challenges for refiners and marketers in a competitive market with significant under-utilized capacity will be many.

Renewable energy sources such as wood, waste, biomass and solar energy show promise but will face tough competition from fossil fuels. Their role in the next few years will be largely confined to market niches (such as the use of wood wastes in the pulp and paper industry and wood for heating in rural areas), although there will be significant opportunities for the longer-term future beyond 2000.

APPENDICES

APPENDICES

Total Ontario Energy Demand by Sector and Fuel

1984 (est.)

(Petajoules)

	Energy Sources								
End Use by Sector	Coal	Oil	NGLs	Natural Gas	Electricity	Hydro	Nuclear	Other	Total
Residential	–	74	12	219	126	–	–	17	448
Commercial	–	52	4	195	116	–	–	–	367
Transportation	–	563	6		2	–	–	–	571
Industrial:									
— Applications	220	84	5	296	137	–	–	72	814
— Petrochemical and Other Non-Energy Uses	–	189	15	–	–	–	–	–	204
Total End Use Energy	220	962	42	710	381	–	–	89	2,404
Plus:									
Own Use and Losses	–	108	–	45	45	–	34	–	232
Electricity Generation	345	3	–	15	–	429	429	1	1,222
Less:									
Electricity Consumption	–	–	–	–	(426)	–	–	–	(426)
Equals:									
Total Primary Energy	565	1,073	42	770	–	429	463	90	3,432

Total Ontario Energy Demand by Sector and Fuel

2000 Base Outlook

(Petajoules)

	Energy Sources								
End Use by Sector	Coal	Oil	NGLs	Natural Gas	Electricity	Hydro	Nuclear	Other	Total
Residential	–	40	11	209	149	–	–	24	433
Commercial	–	25	4	233	178	–	–	3	443
Transportation	–	575	17	6	3	–	–	23	624
Industrial:									
— Applications	294	102	6	386	206	–	–	98	1,092
— Petrochemical and Other Non-Energy Uses	–	177	78	–	–	–	–	–	255
Total End Use Energy	294	919	116	834	536	–	–	148	2,847
Plus:									
Own Use and Losses	–	100	–	48	57	–	20	–	225
Electricity Generation	212	3	–	25	–	440	1,010	5	1,695
Less:									
Electricity Consumption	–	–	–	–	(593)	–	–	–	(593)
Equals:									
Total Primary Energy	506	1,022	116	907	–	440	1,030	153	4,174

Total Ontario Energy Demand by Sector and Fuel

2000 Low Demand Outlook

(Petajoules)

End Use by Sector	Energy Sources								
	Coal	Oil	NGLs	Natural Gas	Electricity	Hydro	Nuclear	Other	Total
Residential	–	20	11	208	148	–	–	33	420
Commercial	–	23	4	208	160	–	–	2	397
Transportation	–	477	20	9	3	–	–	27	536
Industrial:									
– Applications	230	83	5	319	159	–	–	92	888
– Petrochemical and Other Non-Energy Uses	–	167	70	–	–	–	–	–	237
Total End Use Energy	230	770	110	744	470	–	–	154	2,478
Plus:									
Own Use and Losses	–	86	–	42	50	–	20	–	198
Electricity Generation	135	3	–	19	–	440	890	5	1,492
Less:									
Electricity Consumption	–	–	–	–	(520)	–	–	–	(520)
Equals:									
Total Primary Energy	365	859	110	805	–	440	910	159	3,648

Total Ontario Energy Demand by Sector and Fuel

2000 High Demand Outlook

(Petajoules)

	Energy Sources								
End Use by Sector	Coal	Oil	NGLs	Natural Gas	Electricity	Hydro	Nuclear	Other	Total
Residential	–	63	11	209	151	–	–	25	459
Commercial	–	27	4	254	193	–	–	4	482
Transportation	–	714	9	3	3	–	–	22	751
Industrial:									
— Applications	410	125	7	492	261	–	–	112	1,407
— Petrochemical and Other Non-Energy Uses	–	200	96	–	–	–	–	–	296
Total End Use Energy	410	1,129	127	958	608	–	–	163	3,395
Plus:									
Own Use and Losses	–	125	–	56	63	–	20	–	264
Electricity Generation	430	3	–	30	–	440	1,010	5	1,918
Less:									
Electricity Consumption	–	–	–	–	(671)	–	–	–	(671)
Equals:									
Total Primary Energy	840	1,257	127	1,044	–	440	1,030	168	4,906

Demand for Refined Petroleum Products

Base Outlook

(Petajoules)

	1984				
	Residential	Commercial	Transportation	Industrial[3]	Total
Gasoline	–	–	398	10[4]	408
Diesel	–	18	95	30	143
Aviation Fuels	–	–	48	–	48
Heavy Fuel Oil[1]	–	7	22	37	66
Light Fuel Oil[2]	74	27	–	7	108
Total	74	52	563	84	773

	2000				
	Residential	Commercial	Transportation	Industrial[3]	Total
Gasoline	–	–	350	13[4]	363
Diesel	–	9	148	40	197
Aviation Fuels	–	–	43	–	43
Heavy Fuel Oil[1]	–	3	34	41	78
Light Fuel Oil[2]	40	13	–	8	61
Total	40	25	575	102	742

[1] Includes petroleum coke
[2] Includes kerosene and stove oil
[3] Excludes petrochemical and non-energy use
[4] Agriculture gasoline use

Conversion Tables

To relate the energy consumption figures in Petajoules to the common measures used in the energy industries, the following conversions should be used.

Crude Oil	: 1 PJ = 163,400 barrels
Natural Gas Liquids	: 1 PJ = 231,600 barrels
Natural Gas	: 1 PJ = 932,000 thousand cubic feet (Mcf)
Electricity	: 1 PJ = 277,800,000 kilowatt hours (kWh)
Coal (imported bituminous)	: 1 PJ = 33,300 tonnes
Methanol	: 1 PJ = 347,700 barrels
Wood (oven-dried)	: 1 PJ = 50,000 tonnes (approximate)

Hence, the base forecast of Ontario's end-use energy demand in 2000 (Table A2) can be restated using these conversions as:

	PJ	
Crude Oil	919	= 150 million barrels
Natural Gas Liquids	116	= 27 million barrels
Natural Gas	834	= 777 million Mcf
Electricity	536	= 149 billion kWh
Coal	294	= 10 million tonnes
Other	148	
Total	2,847	

Copies of this and the companion publication *Fuelling Ontario's Future* are available free of charge from the Ontario Government Bookstore, 880 Bay St., Toronto. Out-of-town customers write to Publications Services Section, 5th Floor, 880 Bay St., Toronto, Ontario M7A 1N8. Tel. 965-6015. Toll free long distance 1-800-268-7540; in Northwestern Ontario 0-Zenith 67200.
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